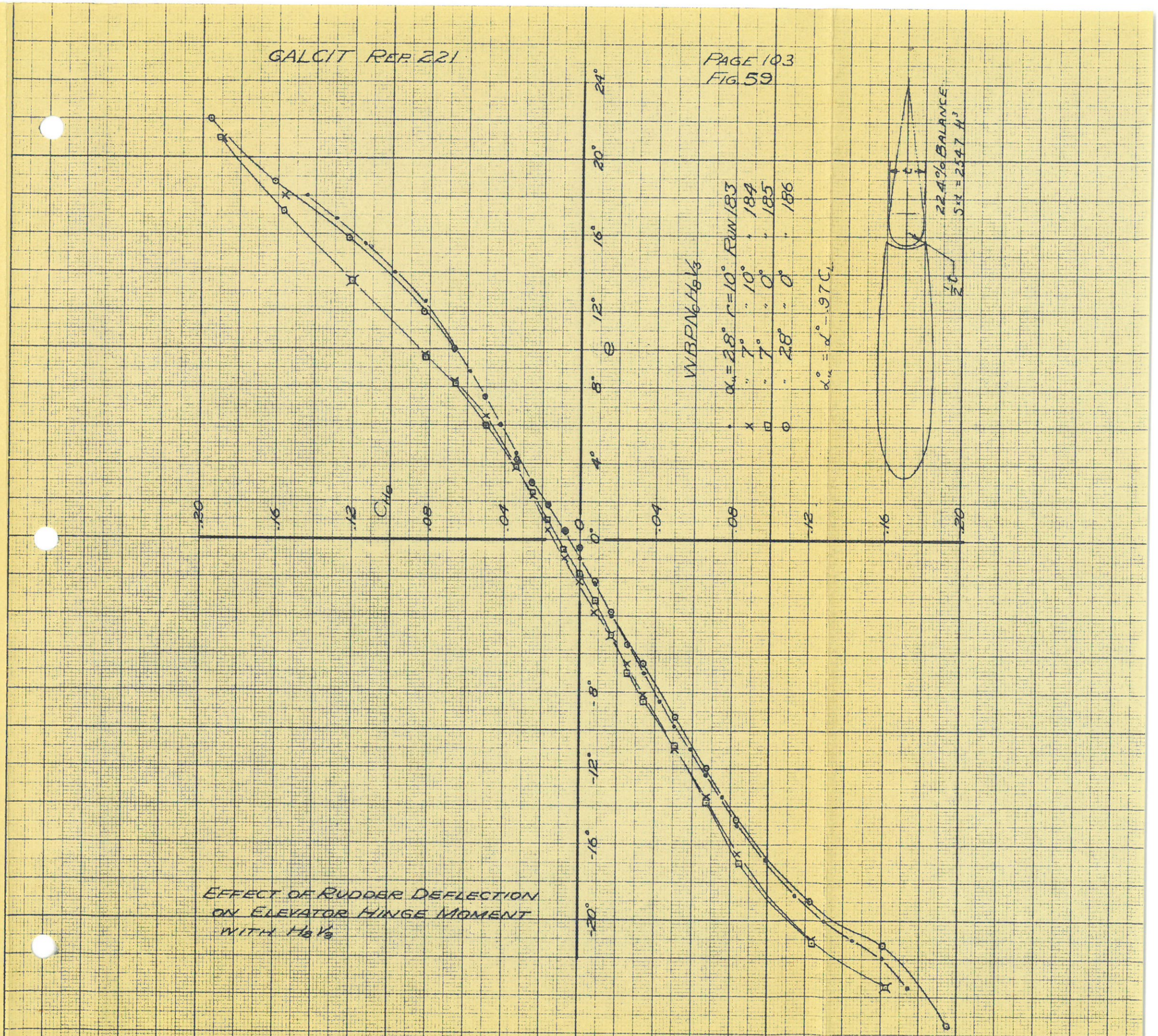
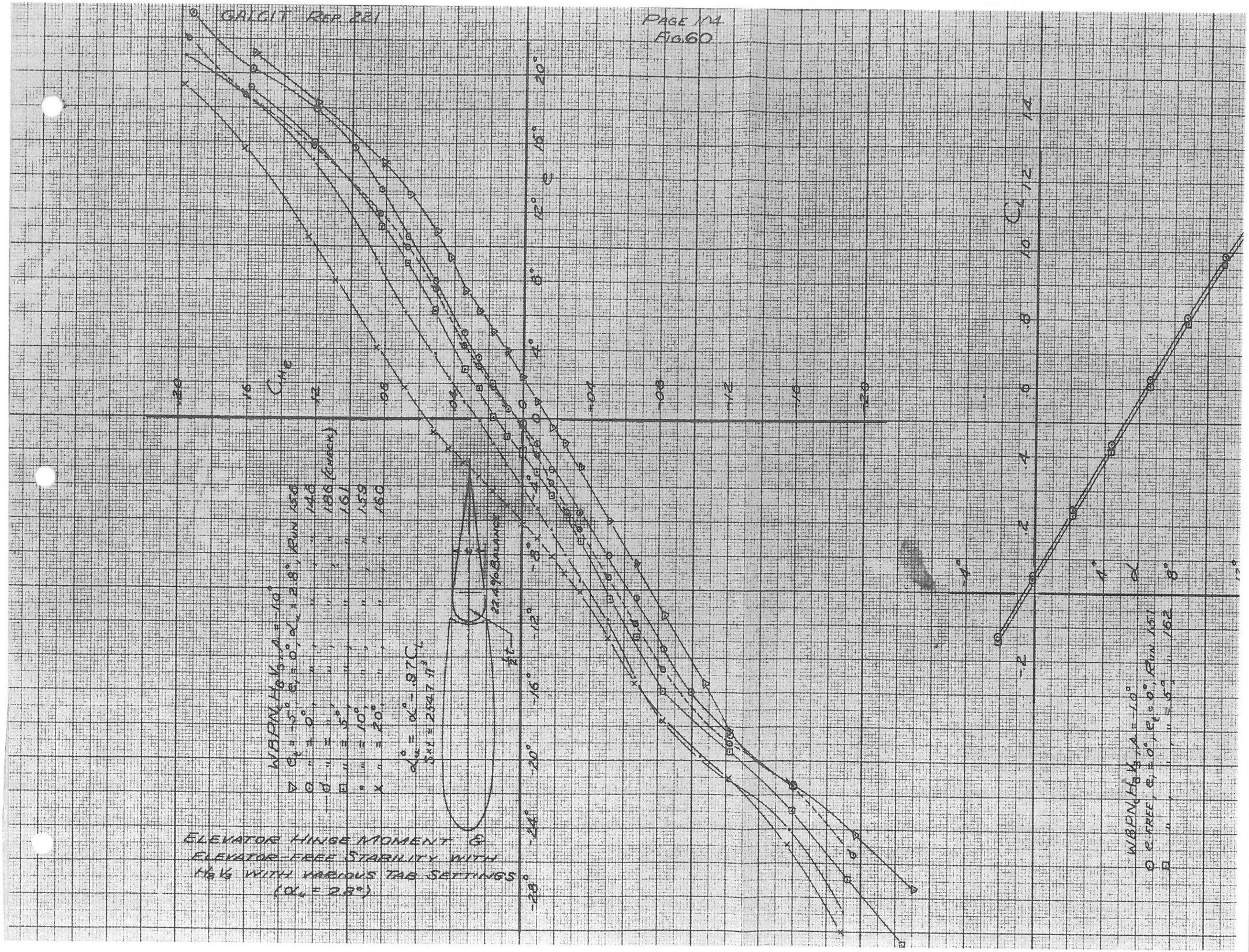
GALCIT REP. 221

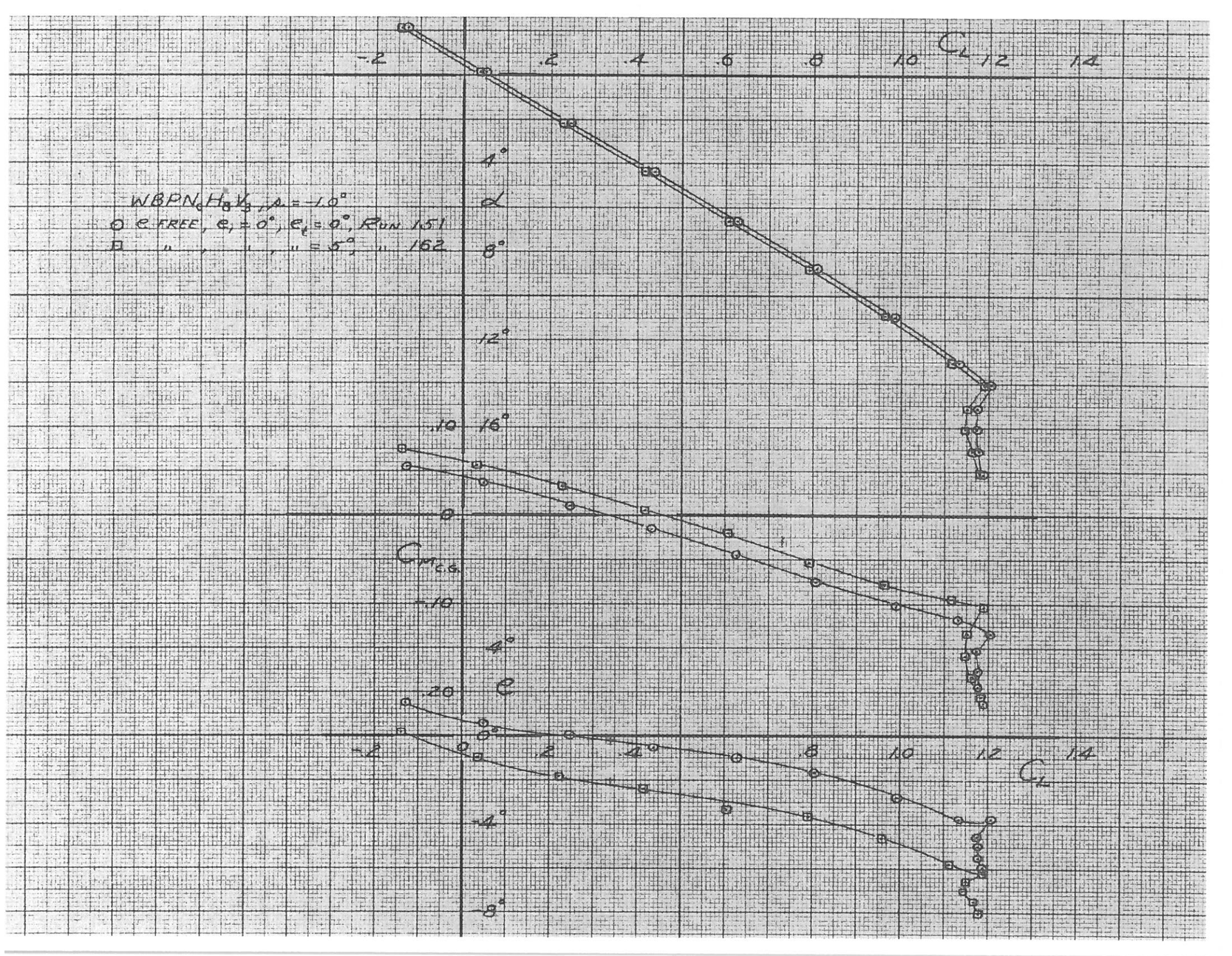
PAGE 103
FIG. 59

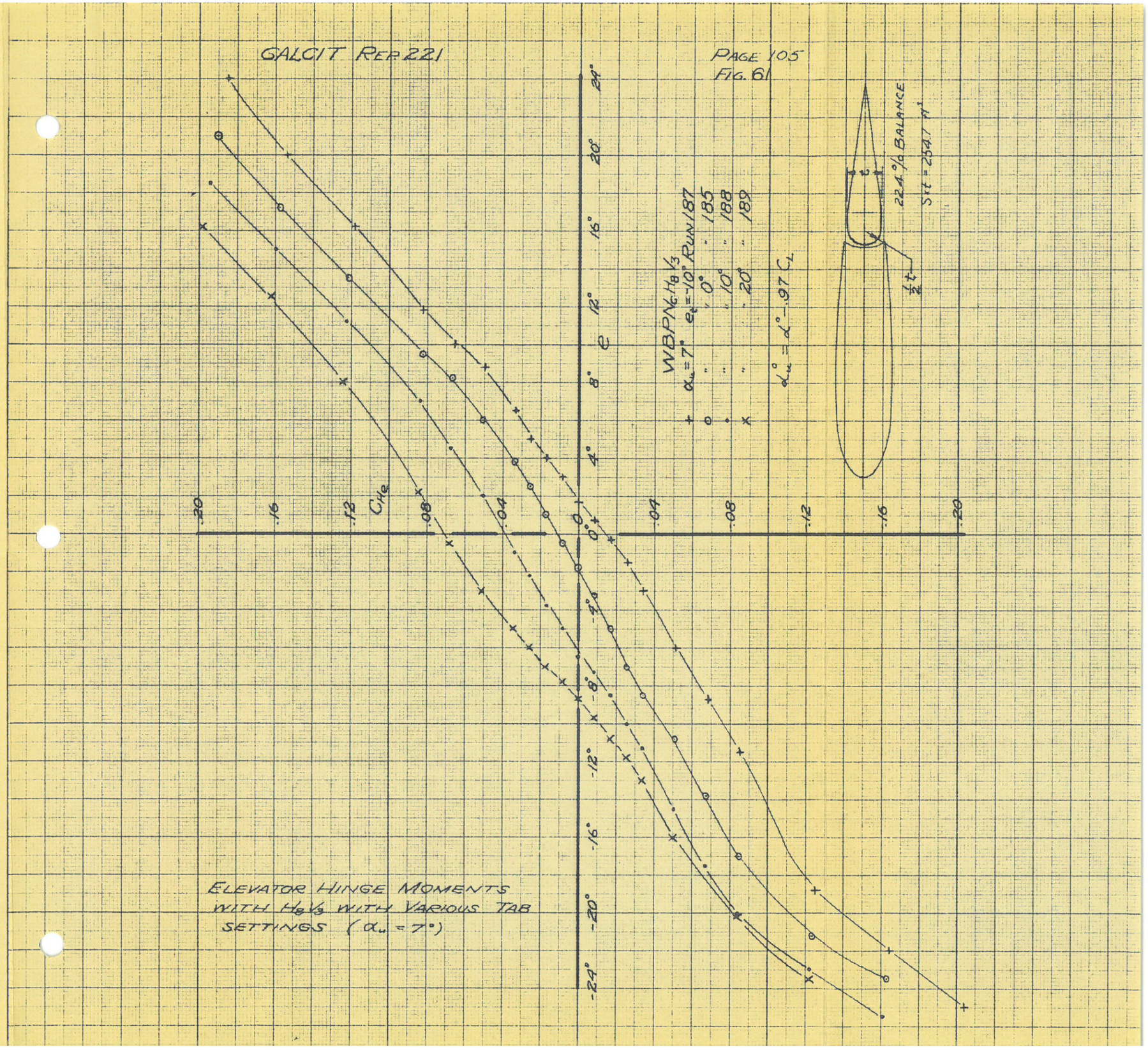


EFFECT OF RUDDER DEFLECTION ON ELEVATOR HINGE MOMENT WITH $H_8 V_8$



ELEVATOR HINGE MOMENT & ELEVATOR-FREE STABILITY WITH $H_8 V_6$ WITH VARIOUS TAB SETTINGS ($\alpha_{0_t} = 2.8^\circ$)


WBPN6H8V3, i_A = -1.0°
○ ℓ FREE, ε_i = 0°, ε_t = 0°, RUN 151
□ " " " " = 5° " 162
C_L
-.2
.2
.4
.6
.8
1.0
1.2
1.4
4°
α
8°
12°
16°
.10
0
C_M c.g.
-.10
-4°
C_D
.20
-4°
-8°



ELEVATOR HINGE MOMENTS WITH H8 V3 WITH VARIOUS TAB SETTINGS ($\alpha_w = 7°$)

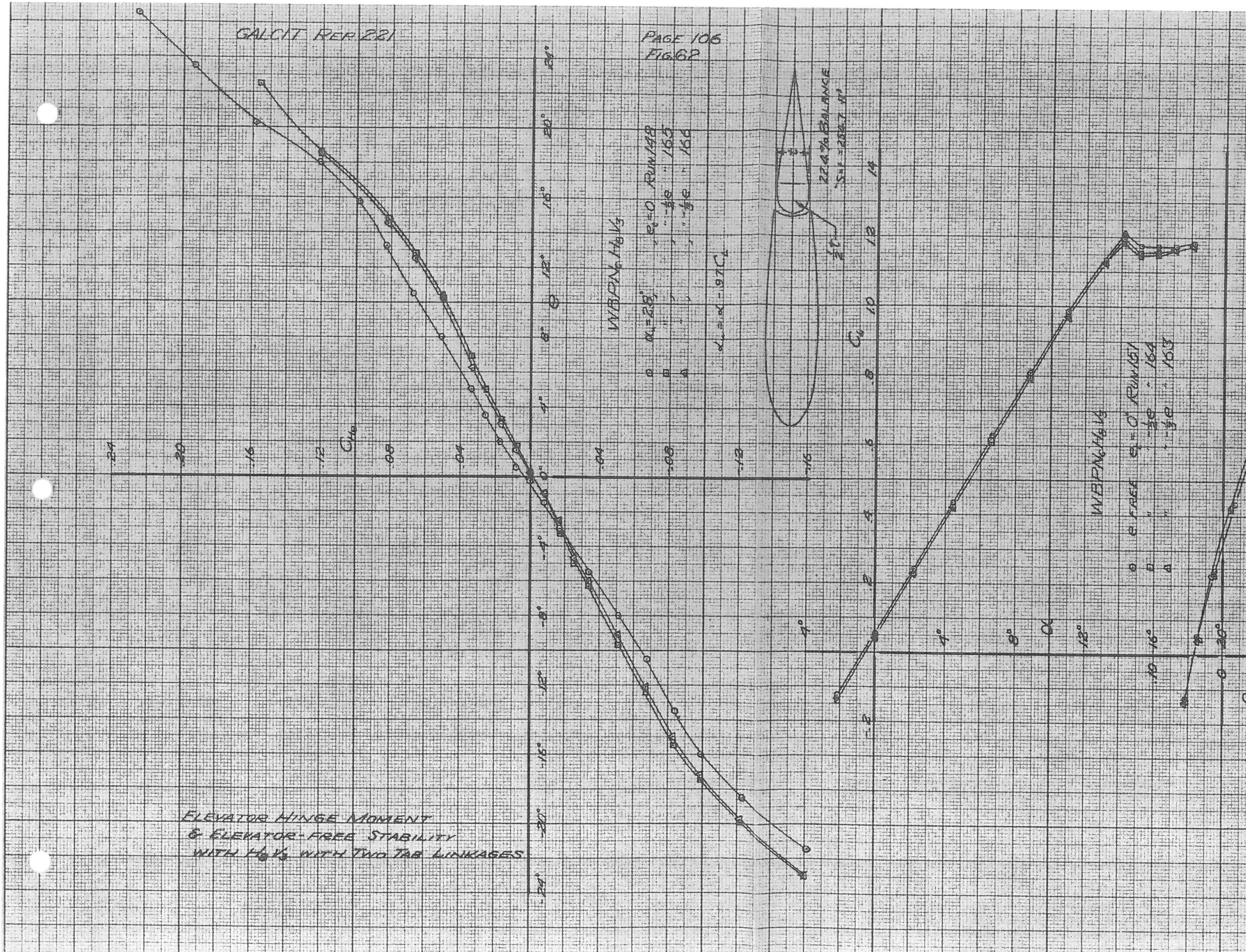
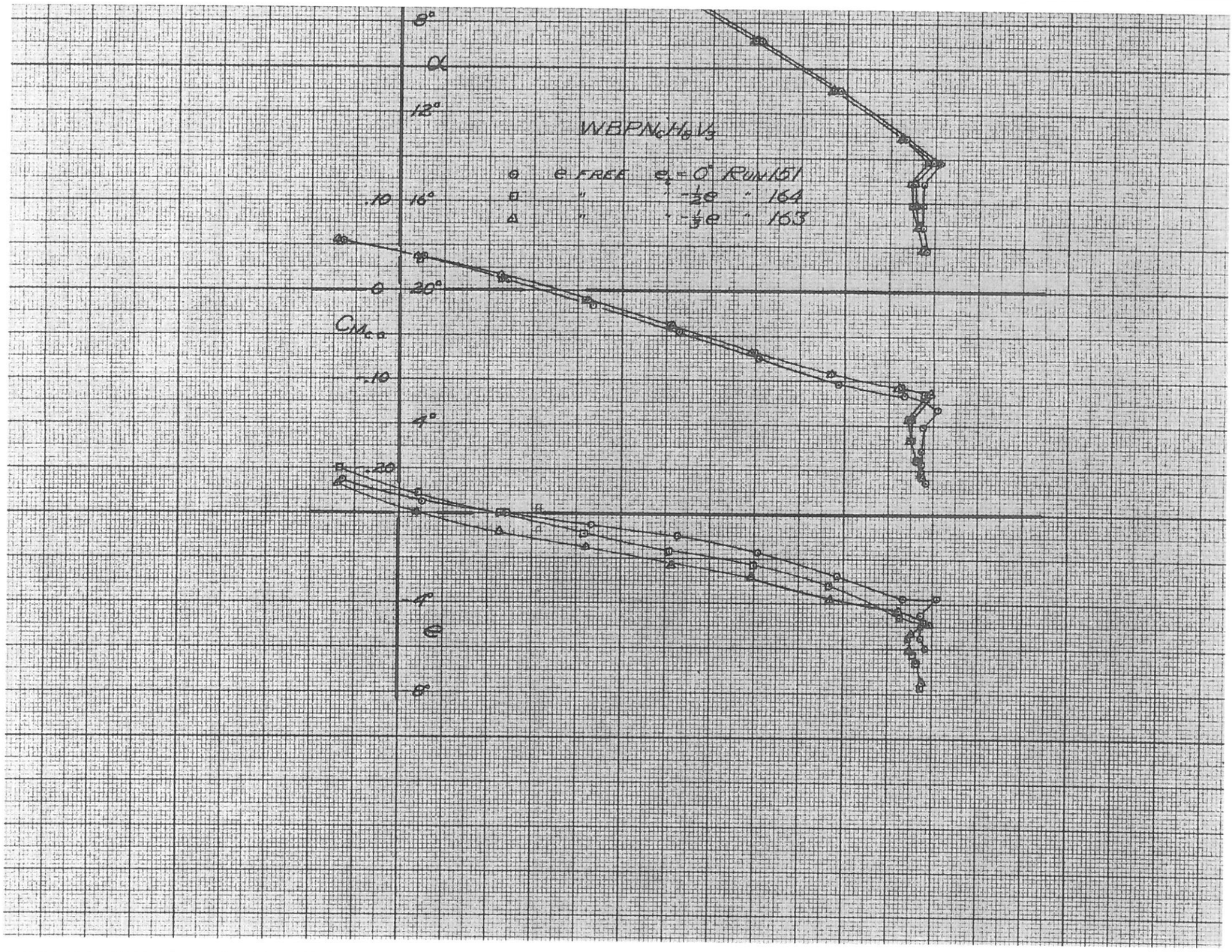
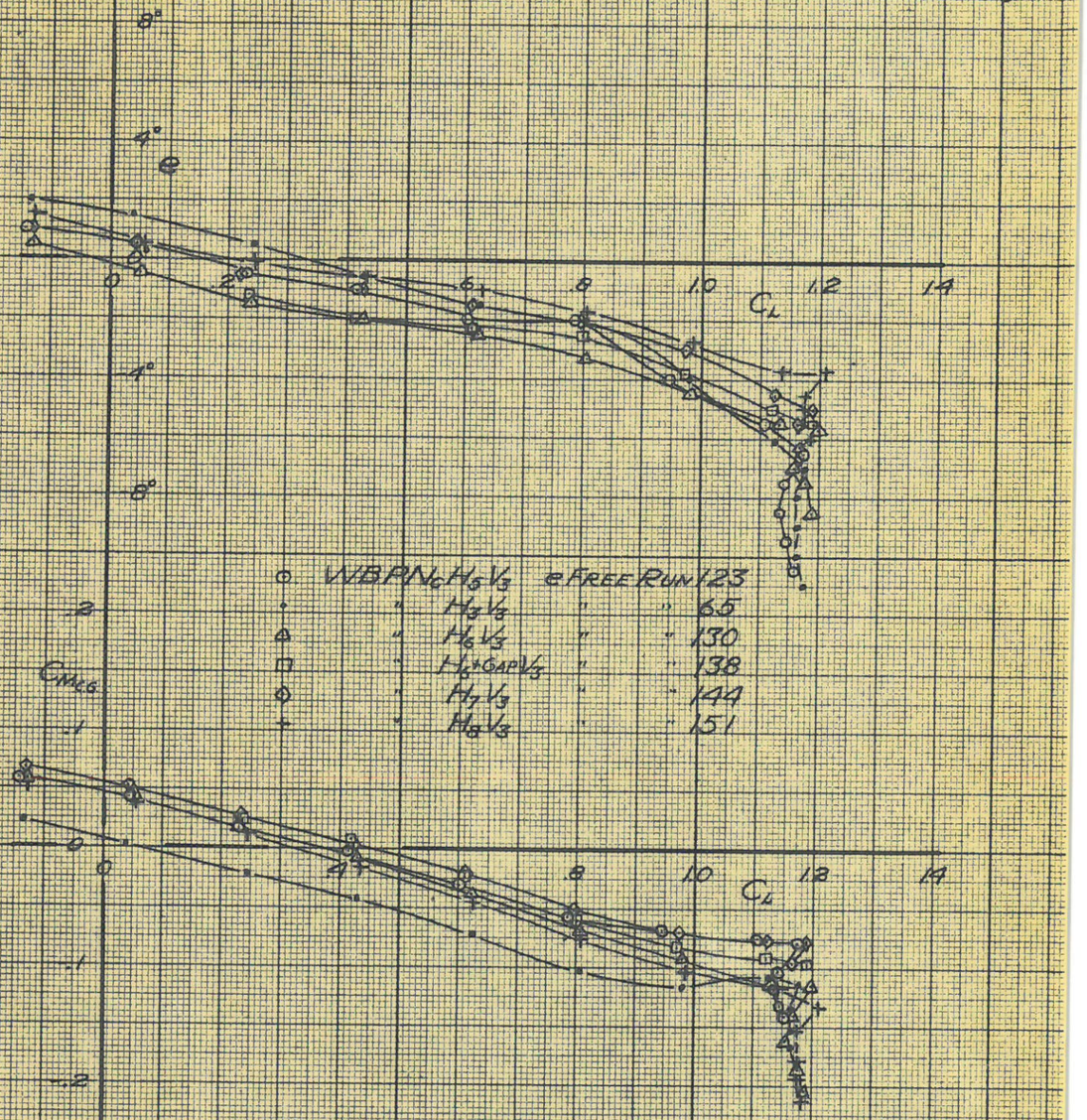


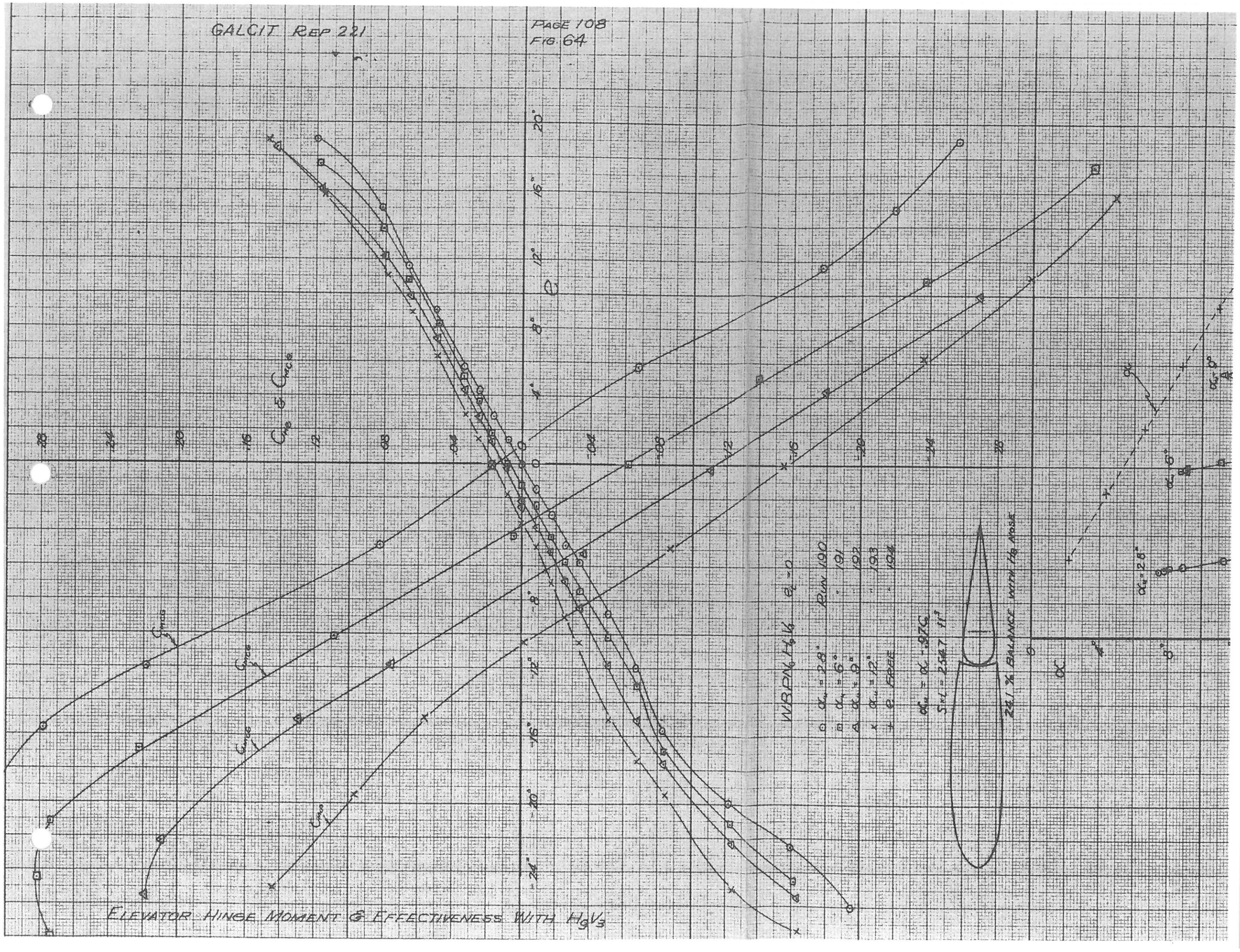
FIG 62

ELEVATOR HINGE MOMENT
& ELEVATOR-FREE STABILITY
WITH H_6V_3 WITH TWO TAB LINKAGES

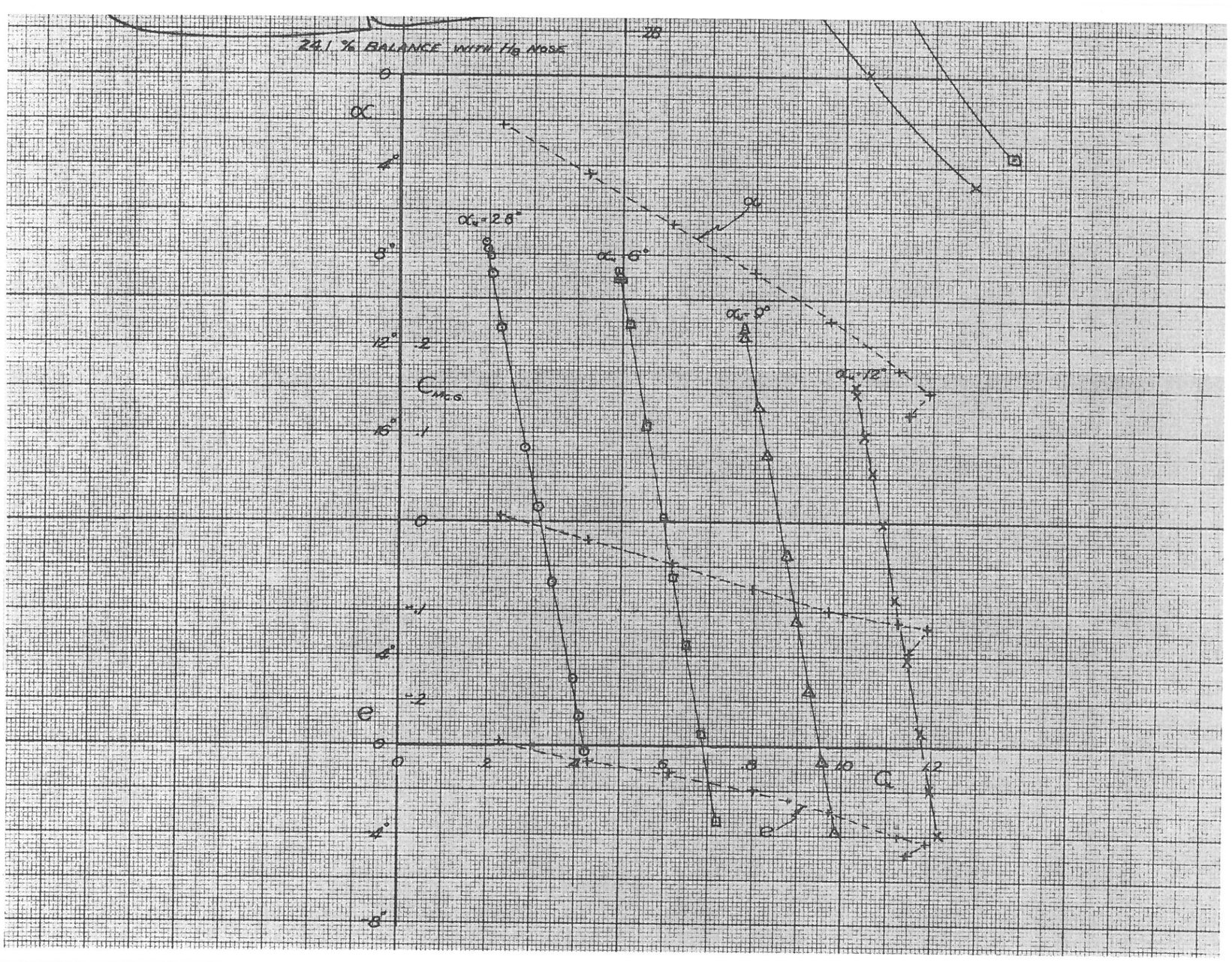

8°
α
12°
WBPN6H6V2
e FREE e_t=0° RUN 161
" " -⅓e " 164
" " -⅓e " 163
16°
.10
0
20°
$C_{M_{c.g.}}$
-.10
4°
-.20
-4°
e
-8°

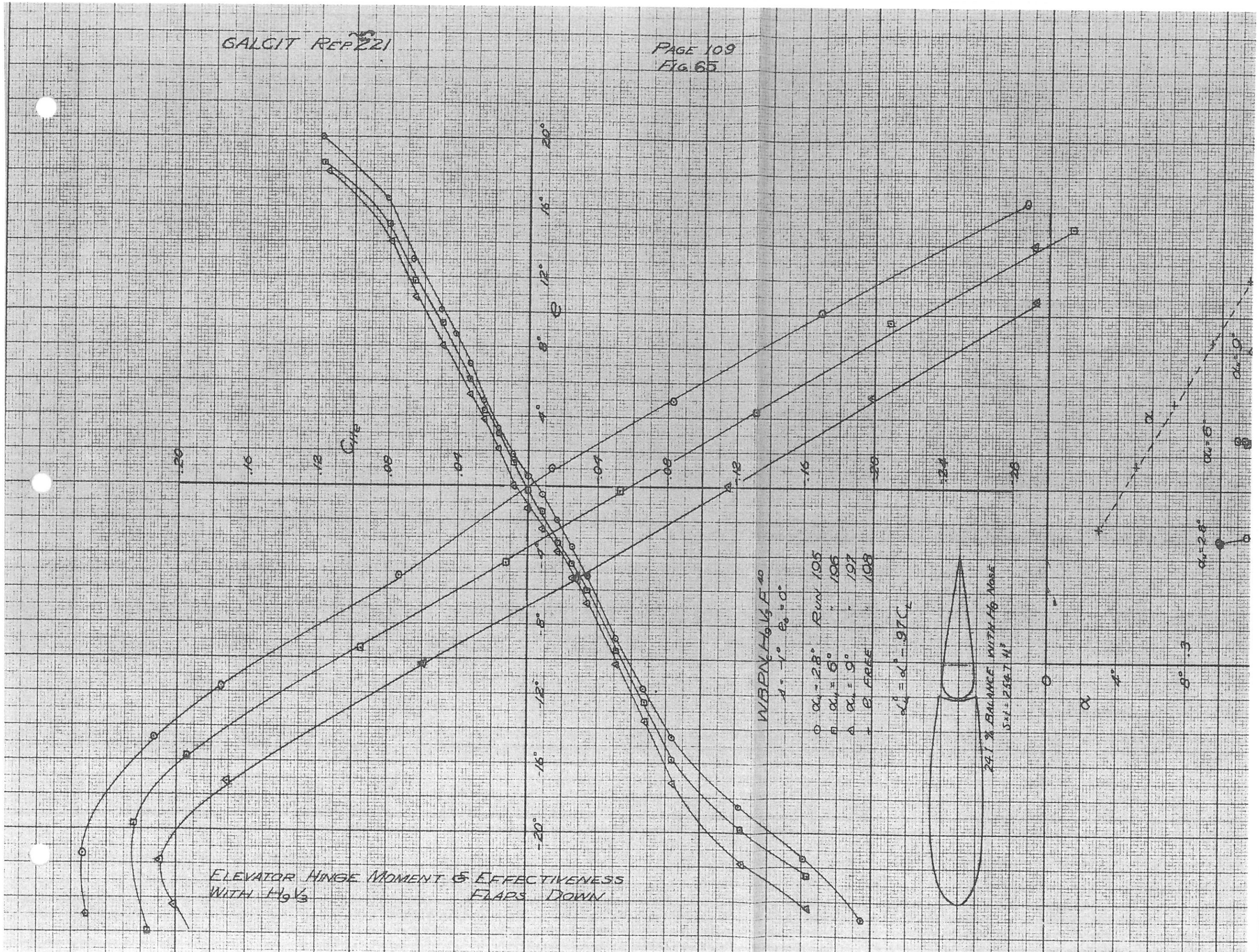


COMPARISON OF VARIOUS ELEVATORS ($H_{3,5,6,7,8}$)
STABILITY WITH ELEVATOR FREE

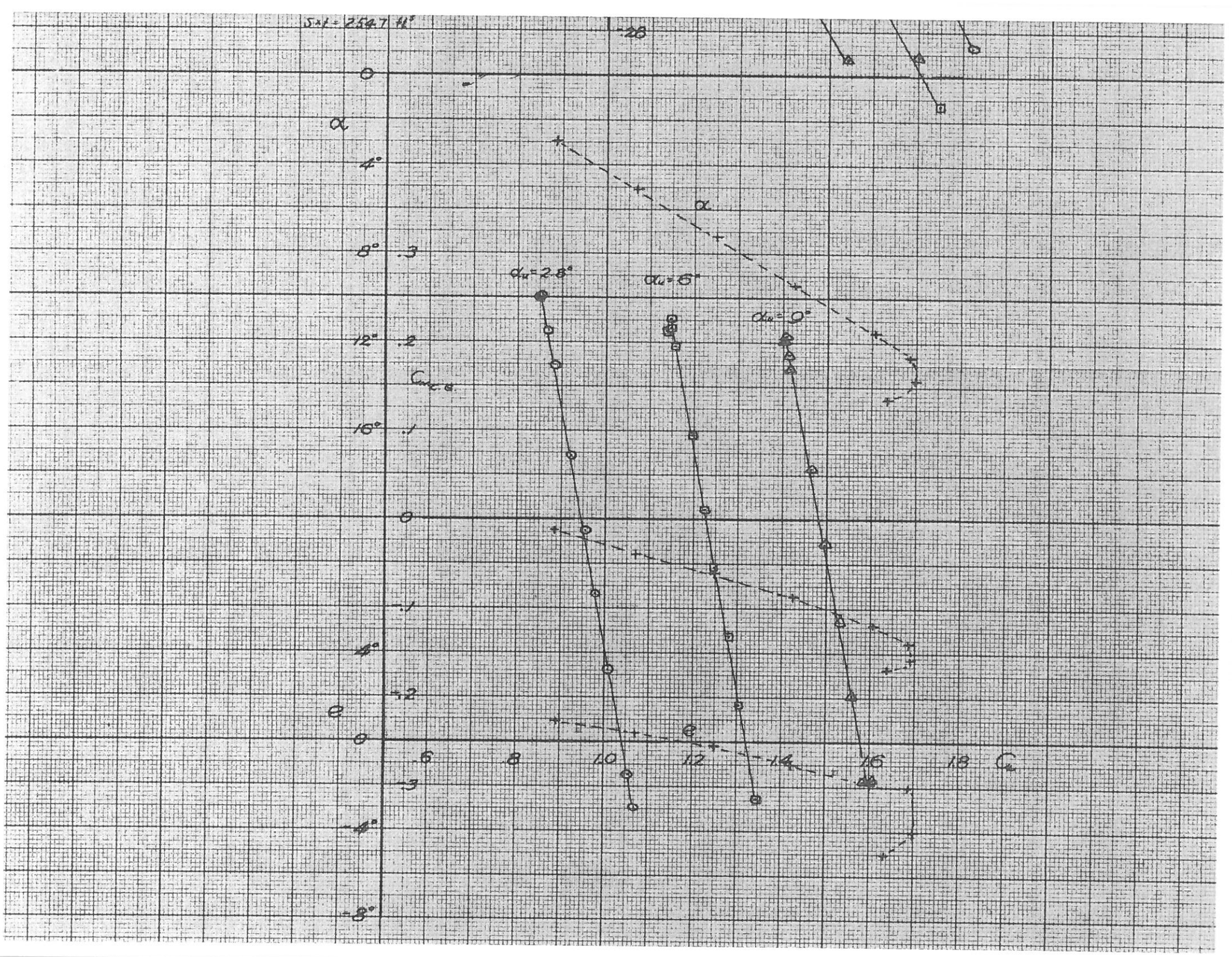


ELEVATOR HINGE MOMENT & EFFECTIVENESS WITH H_6V_3


24.1 % BALANCE WITH H.B NOSE
α
$C_{M.c.}$
e
C_L
α_w=28°
α_w=6°
α_w=0°
α_w=-12°



ELEVATOR HINGE MOMENT & EFFECTIVENESS WITH $H_9 V_3$ FLAPS DOWN


S×l = 254.7 ft²
-28
0
α
4°
8°
12°
16°
.3
.2
.1
0
-.1
-.2
-4°
-8°
$C_{L_{\alpha}}$
α_w = 2.8°
α_w = 5°
α_w = 0°
α
e
6
8
10
12
14
16
18
C_m

ELEVATOR HINGE MOMENT WITH H_9V_3 WITH VARIOUS TAB SETTINGS

GALCIT REP 221

PAGE 110
FIG 66

C_{He}

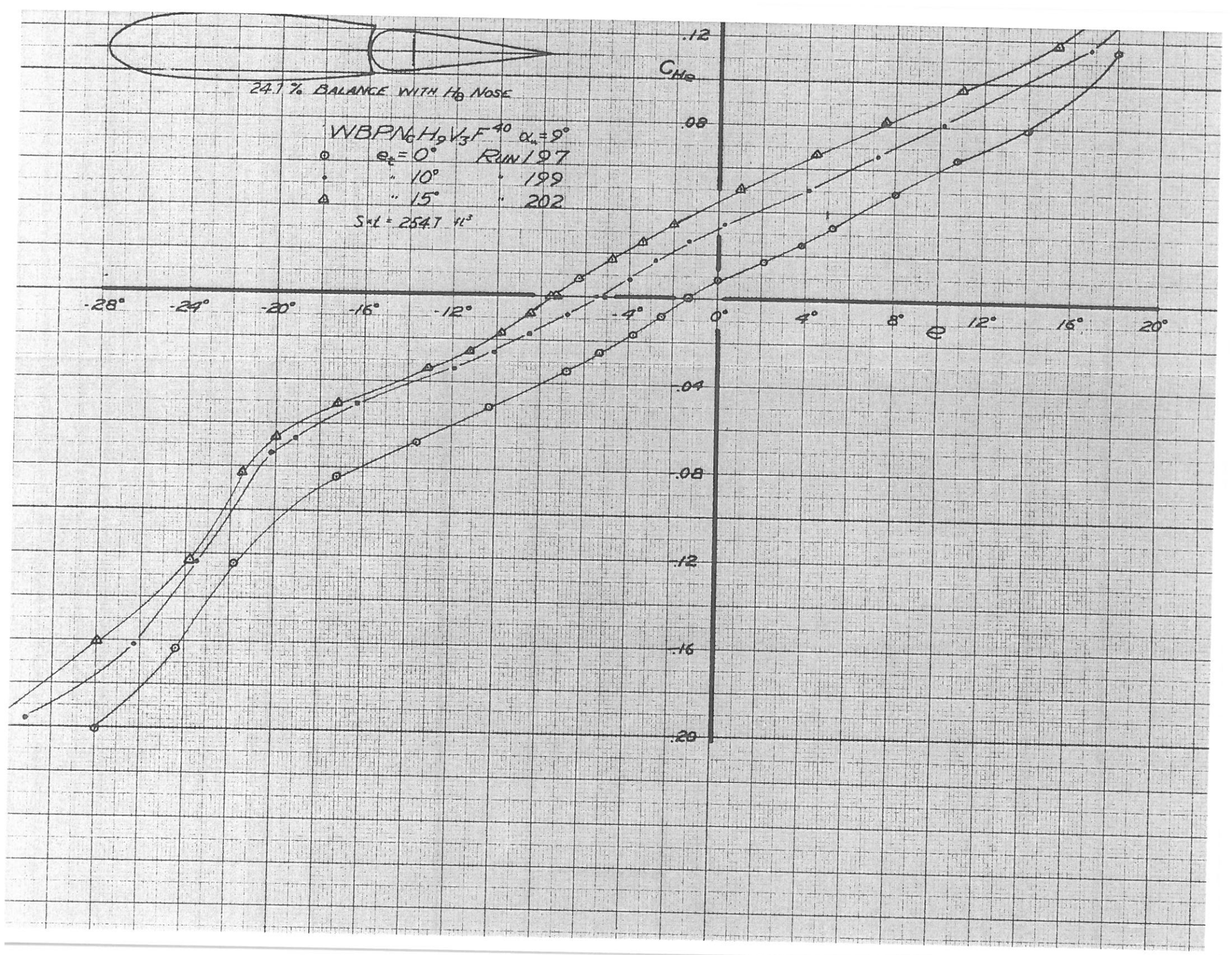
α

WBPN$_6$H$_9$V$_3$ $\alpha_w = 9°$
- $e_t = 0°$ RUN 192
- " 10° " 200
- " 15° " 201

WBPN$_6$H$_9$V$_3$F^{40} $\alpha_w = 9°$
- $e_t = 0°$ RUN 197
- " 10° " 199
- " 15° " 202

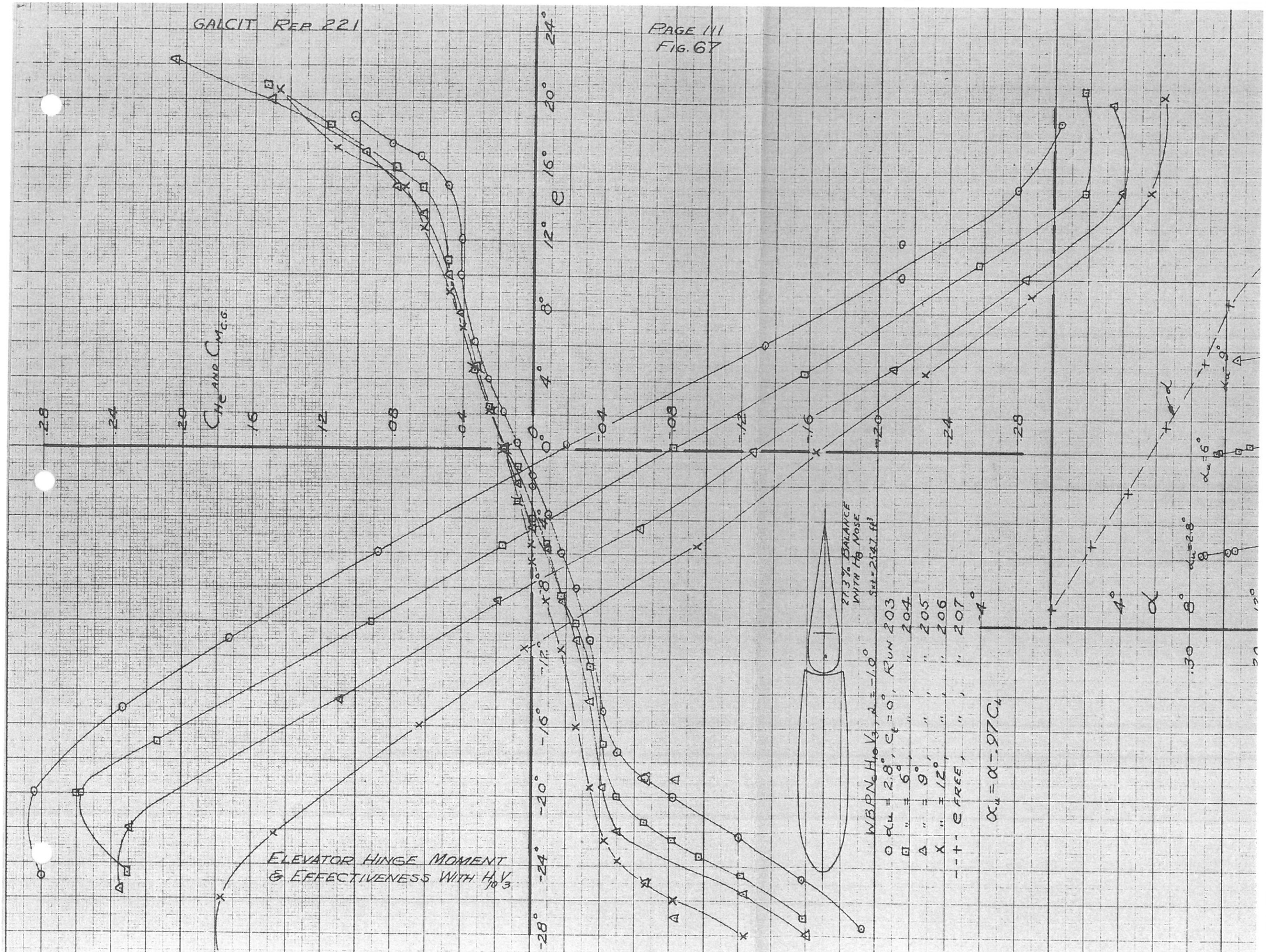
S+L = 284.7 ft^2

24.1 % BALANCE WITH H_8 NOSE

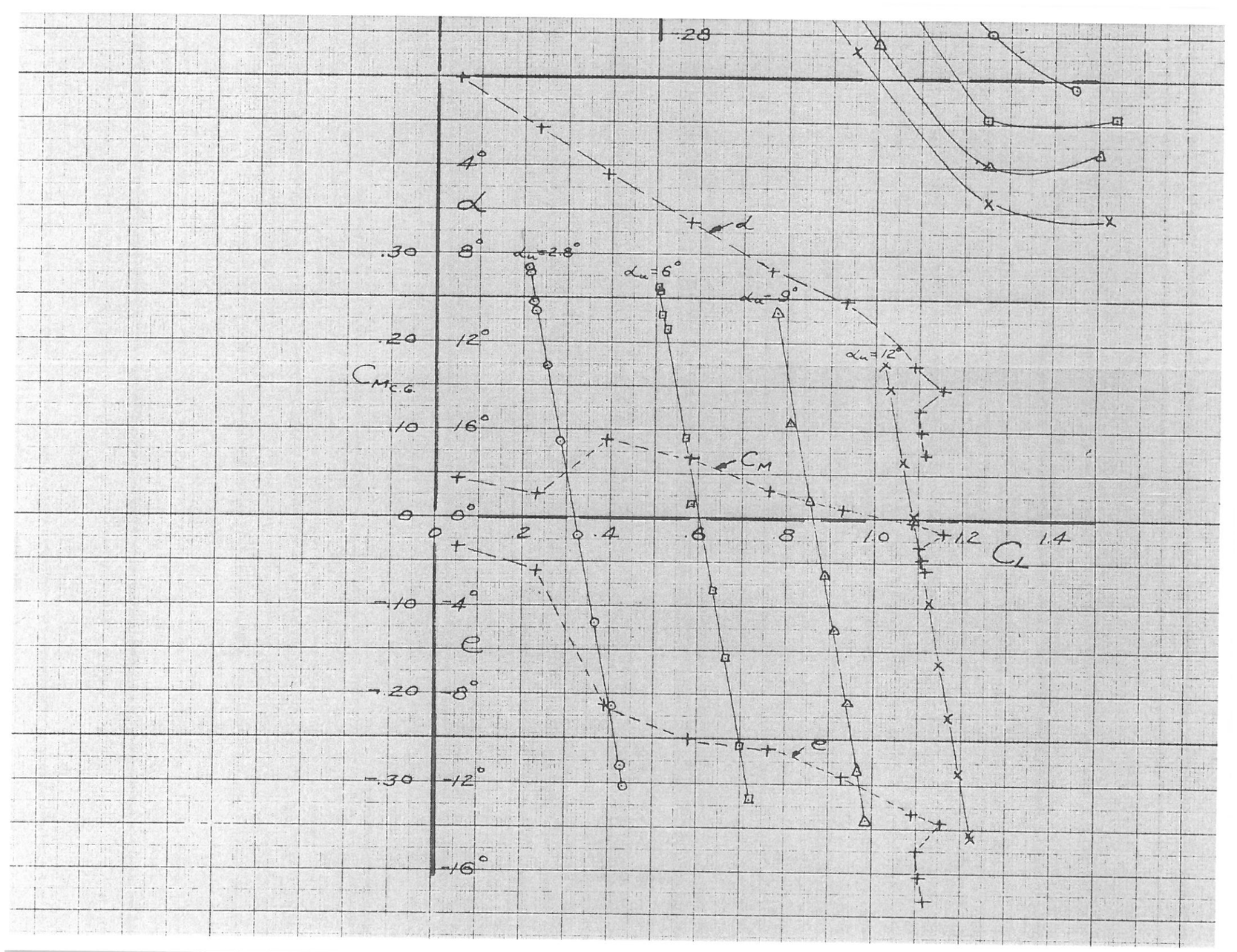

24.1 % BALANCE WITH H_8 NOSE
WBPN6H9V3F40 $\alpha_w = 9°$
$e_t = 0°$ RUN 197
" 10° " 199
" 15° " 202
S×L = 254.7 ft²
C_{H_e}
.12
.08
.04
-.04
-.08
-.12
-.16
-.20
-28°
-24°
-20°
-16°
-12°
-8°
-4°
0°
4°
8°
12°
16°
20°
e

GALCIT REP 221

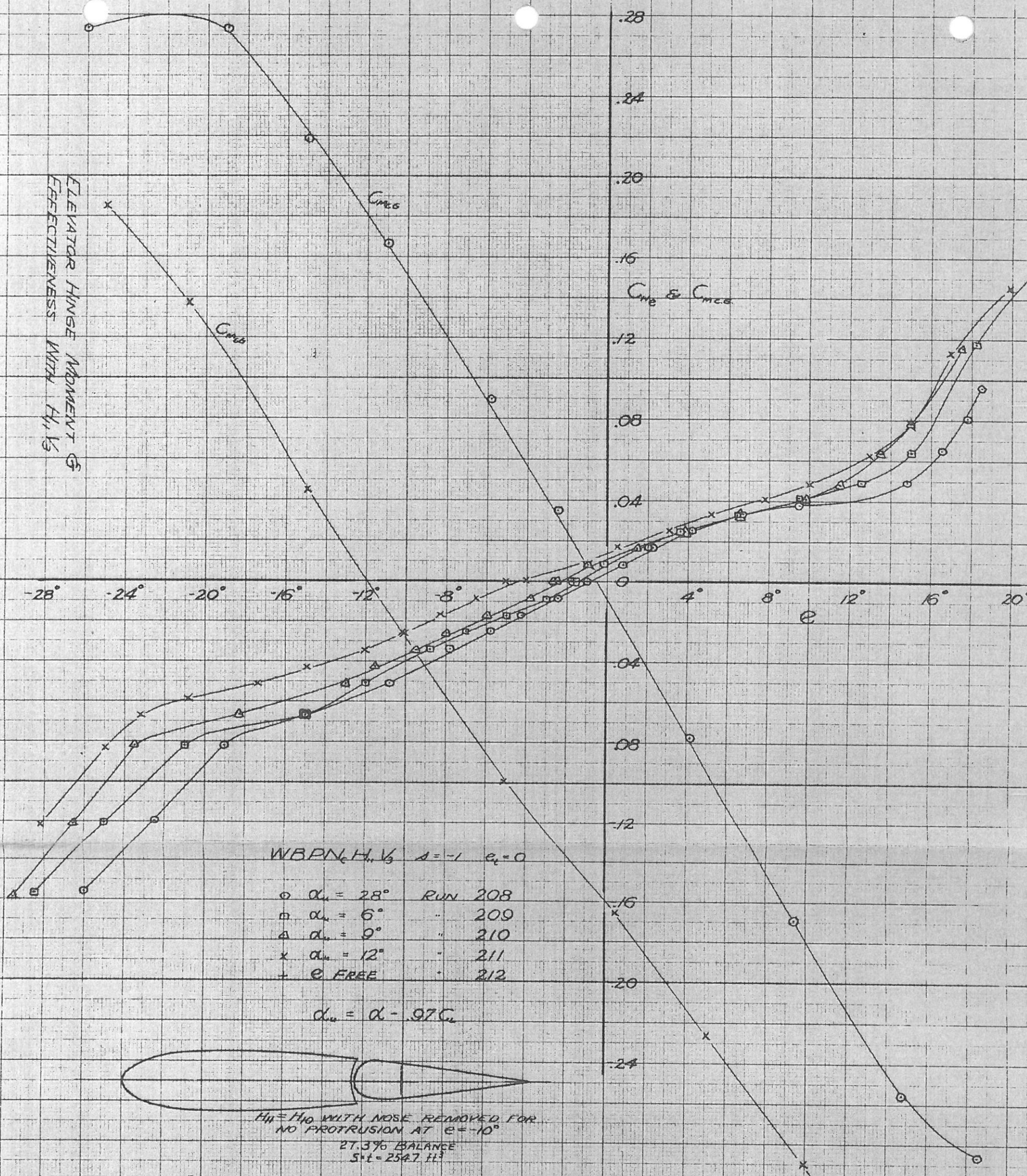
PAGE 111
FIG. 67



ELEVATOR HINGE MOMENT & EFFECTIVENESS WITH $H_{10}V_3$


.28
4°
α
8°
.30
α_w=2.8°
α_w=6°
α_w=9°
α_w=12°
12°
.20
$C_{M_{c.g.}}$
.10
16°
C_M
0
0°
0
.2
.4
.6
.8
1.0
1.2
1.4
C_L
-.10
-4°
ε
-.20
-8°
-.30
-12°
-16°

ELEVATOR HINGE MOMENT & EFFECTIVENESS WITH H_4, V_3

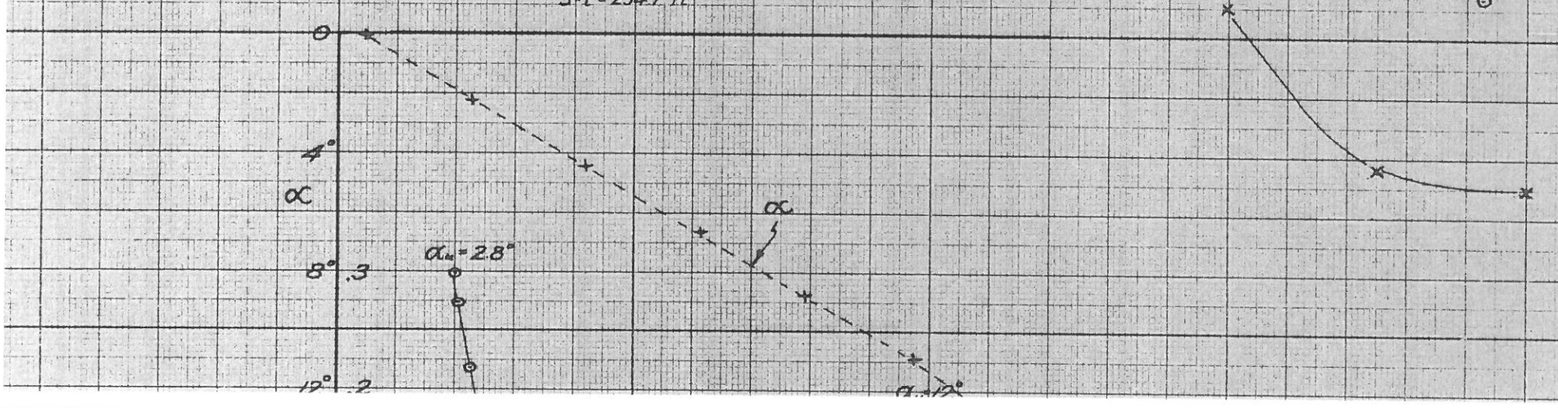


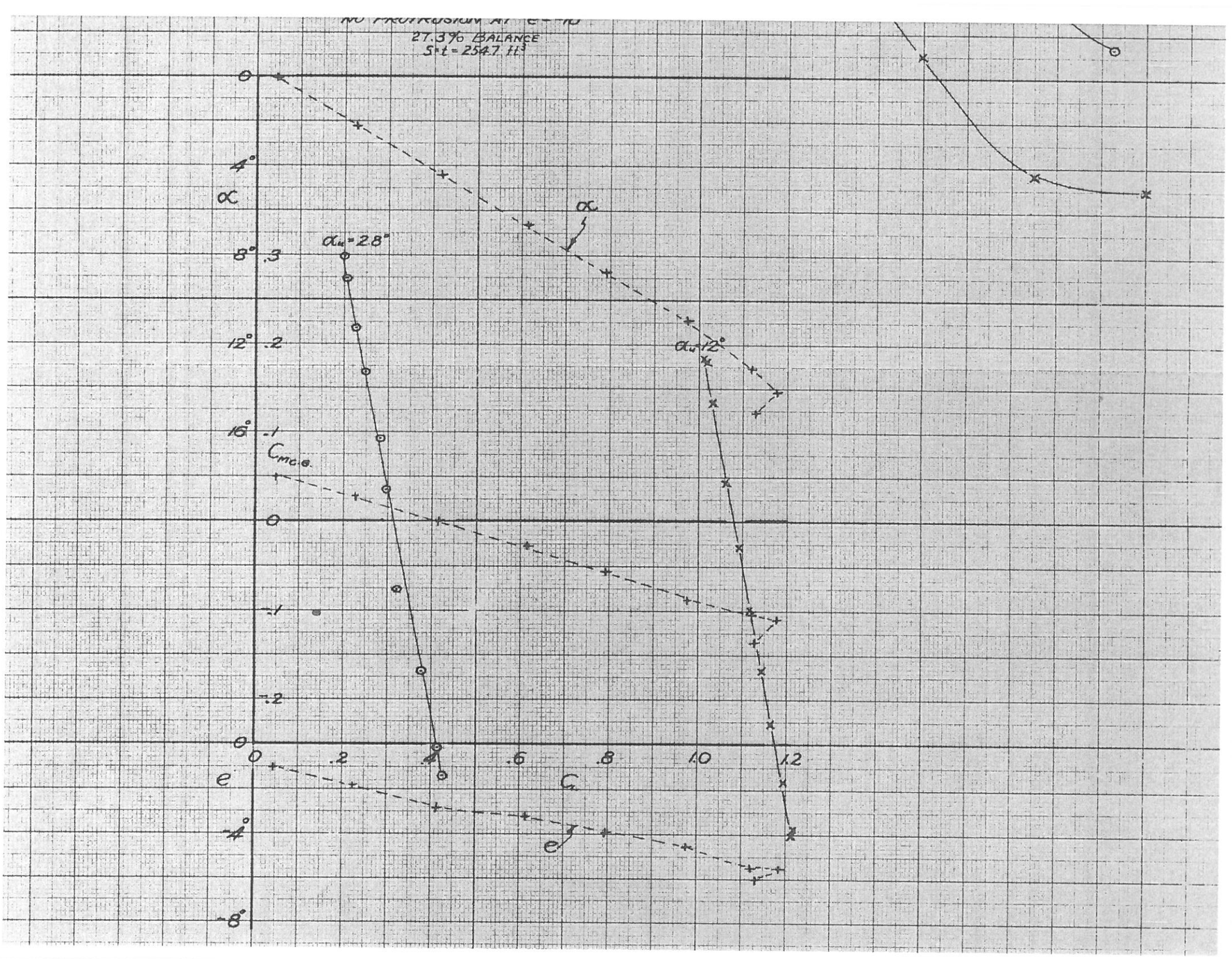
WBPN$_6$ H_4, V_3 $A = -1$ $e_t = 0$

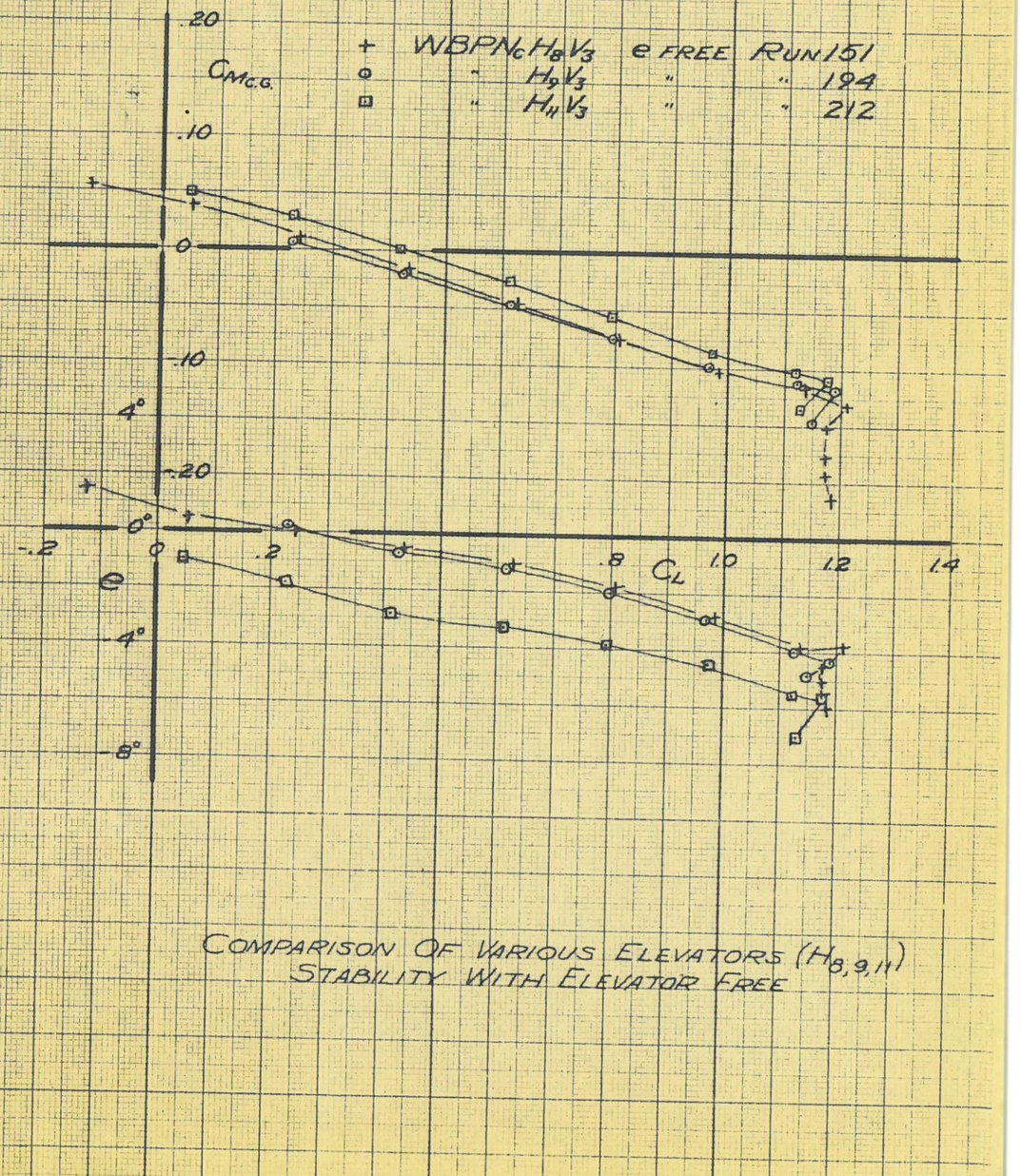
○	α_w = 28°	RUN	208
□	α_w = 6°	"	209
△	α_w = 9°	"	210
×	α_w = 12°	"	211
+	e FREE	"	212

$\alpha_w = \alpha - .97 C_L$

$H_4 = H_{10}$ WITH NOSE REMOVED FOR NO PROTRUSION AT $e = -10°$
27.3% BALANCE
$S \cdot t = 2547$ IN.^{3}

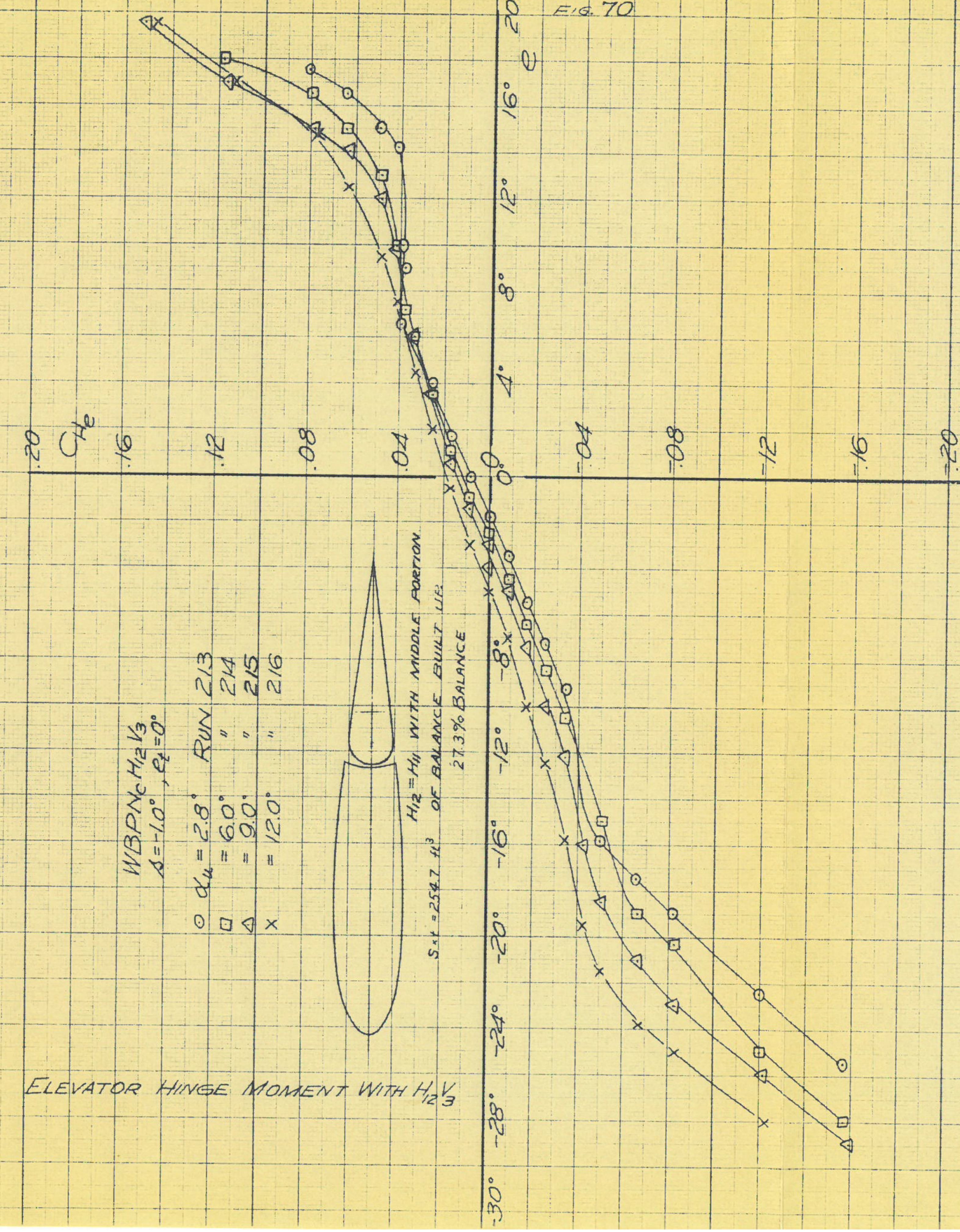



NO PROTRUSION AT
27.3% BALANCE
S·t = 254.7 in³
α
α_w = 2.8°
α_w 12°
$C_{m_{c.g.}}$
C_N
e
0
4°
8°
12°
16°
.3
.2
.1
-.1
-.2
.2
.4
.6
.8
1.0
1.2
-4°
-8°



COMPARISON OF VARIOUS ELEVATORS ($H_{8,9,11}$)
STABILITY WITH ELEVATOR FREE

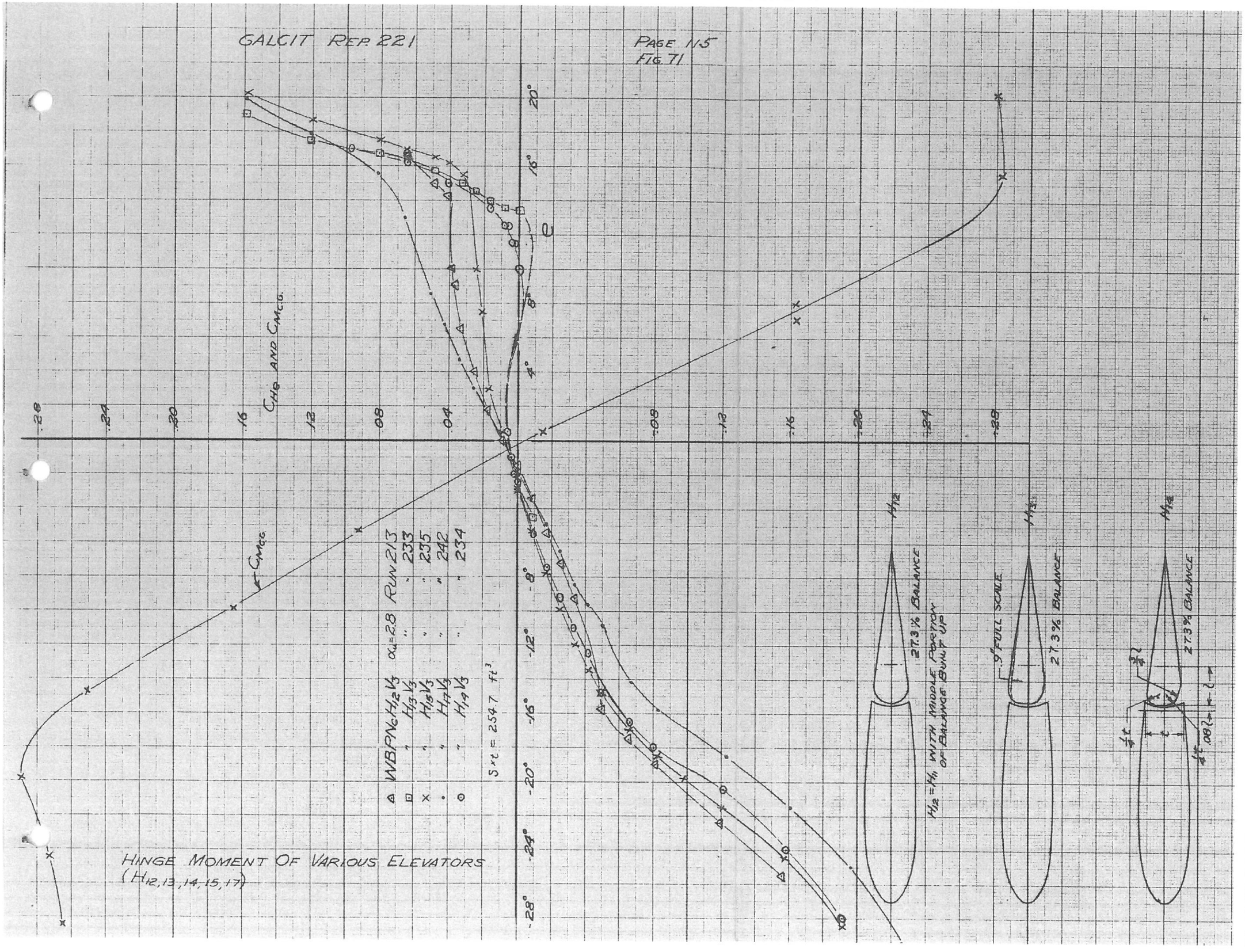
FIG. 70



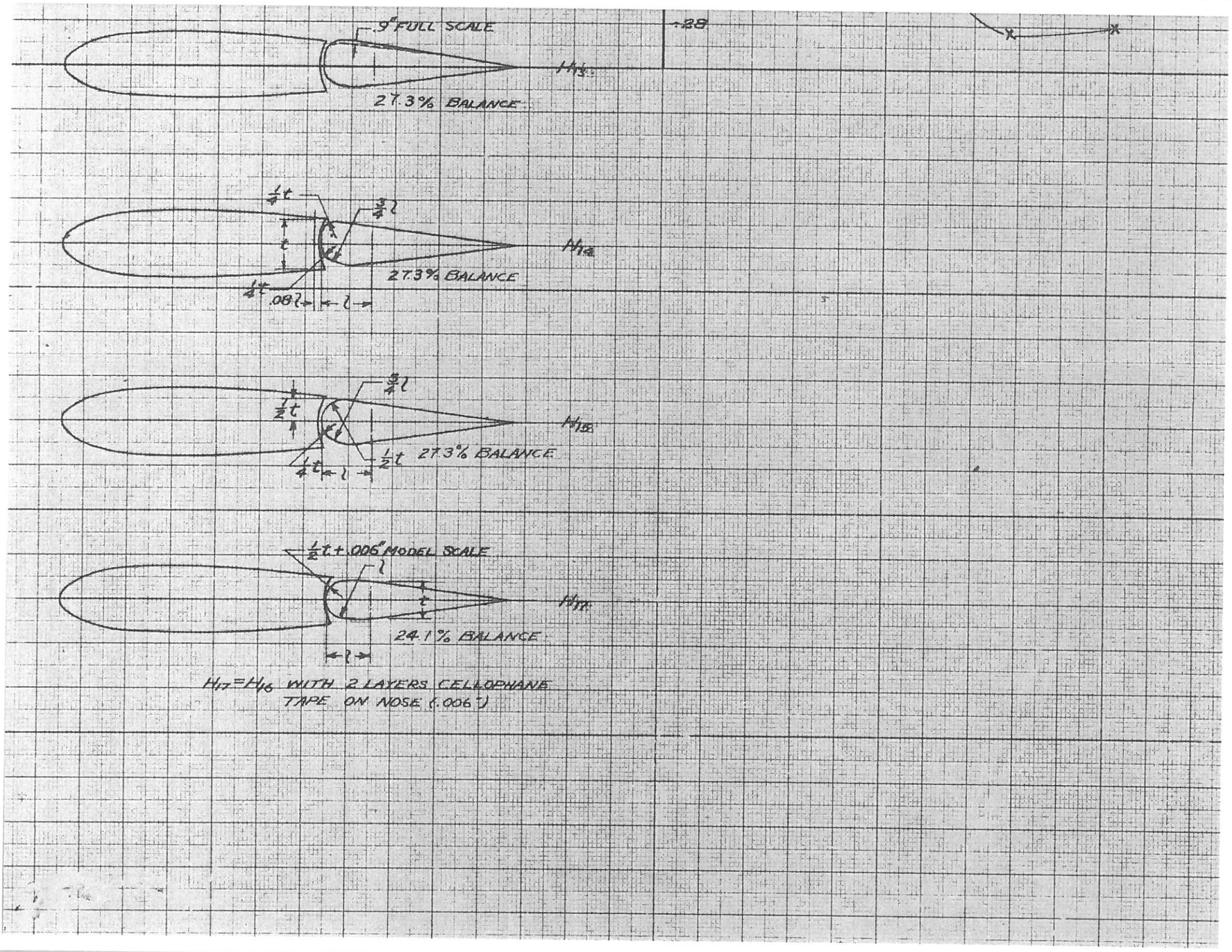
ELEVATOR HINGE MOMENT WITH $H_{12}V_3$

GALCIT REP. 221

PAGE 115
FIG. 71



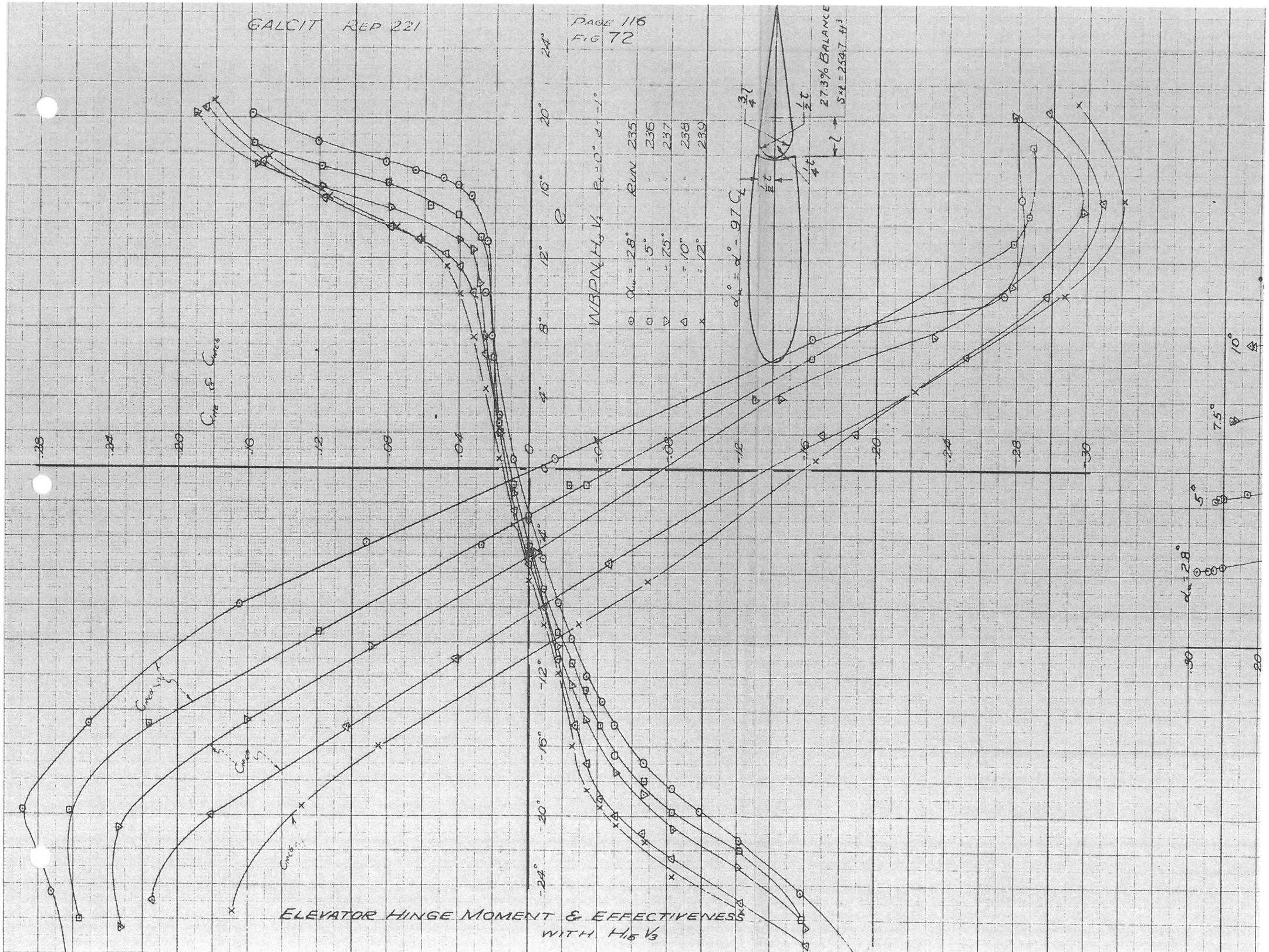
HINGE MOMENT OF VARIOUS ELEVATORS
($H_{12,13,14,15,17}$)



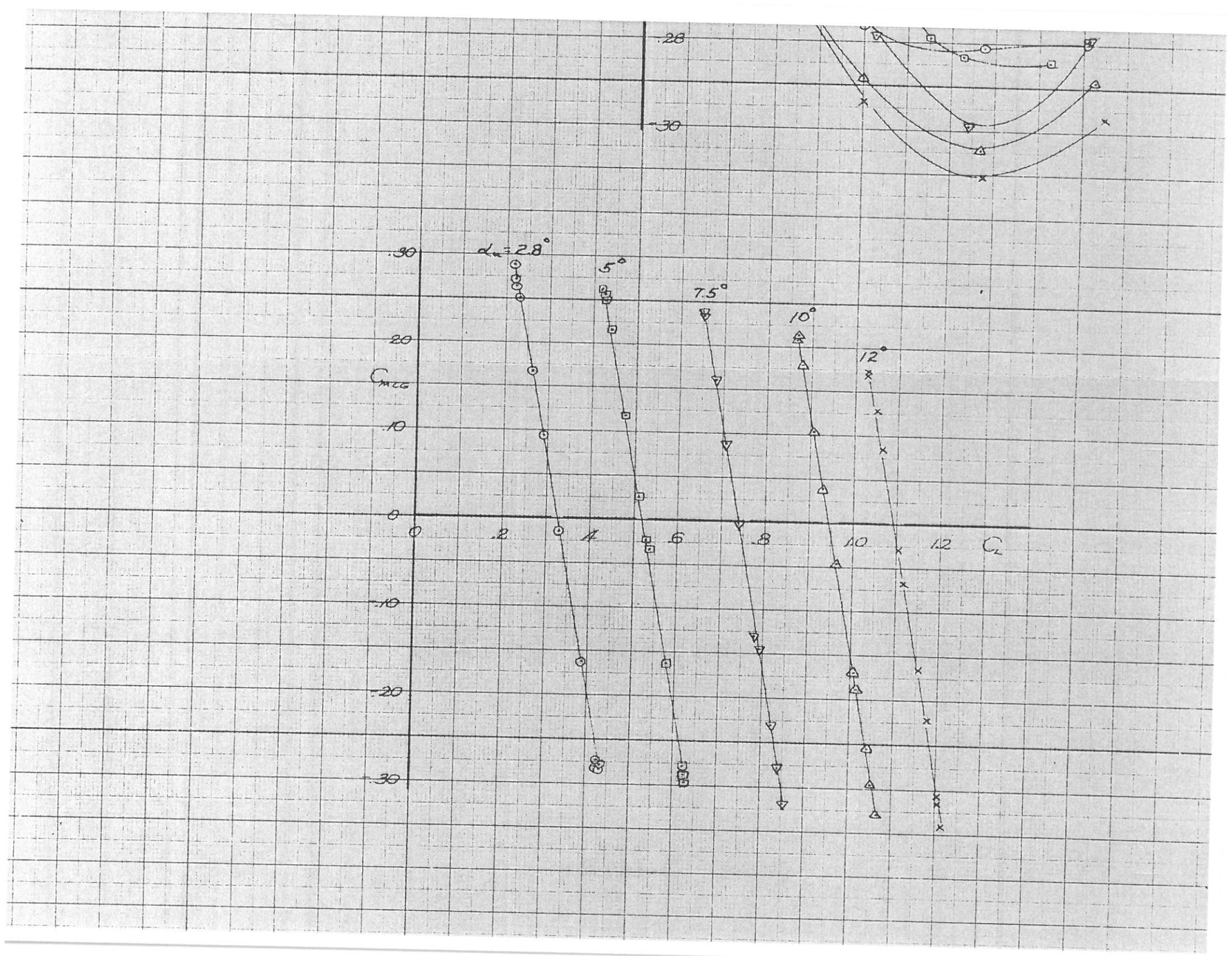
$H_{17} = H_{16}$ WITH 2 LAYERS CELLOPHANE TAPE ON NOSE (.006")

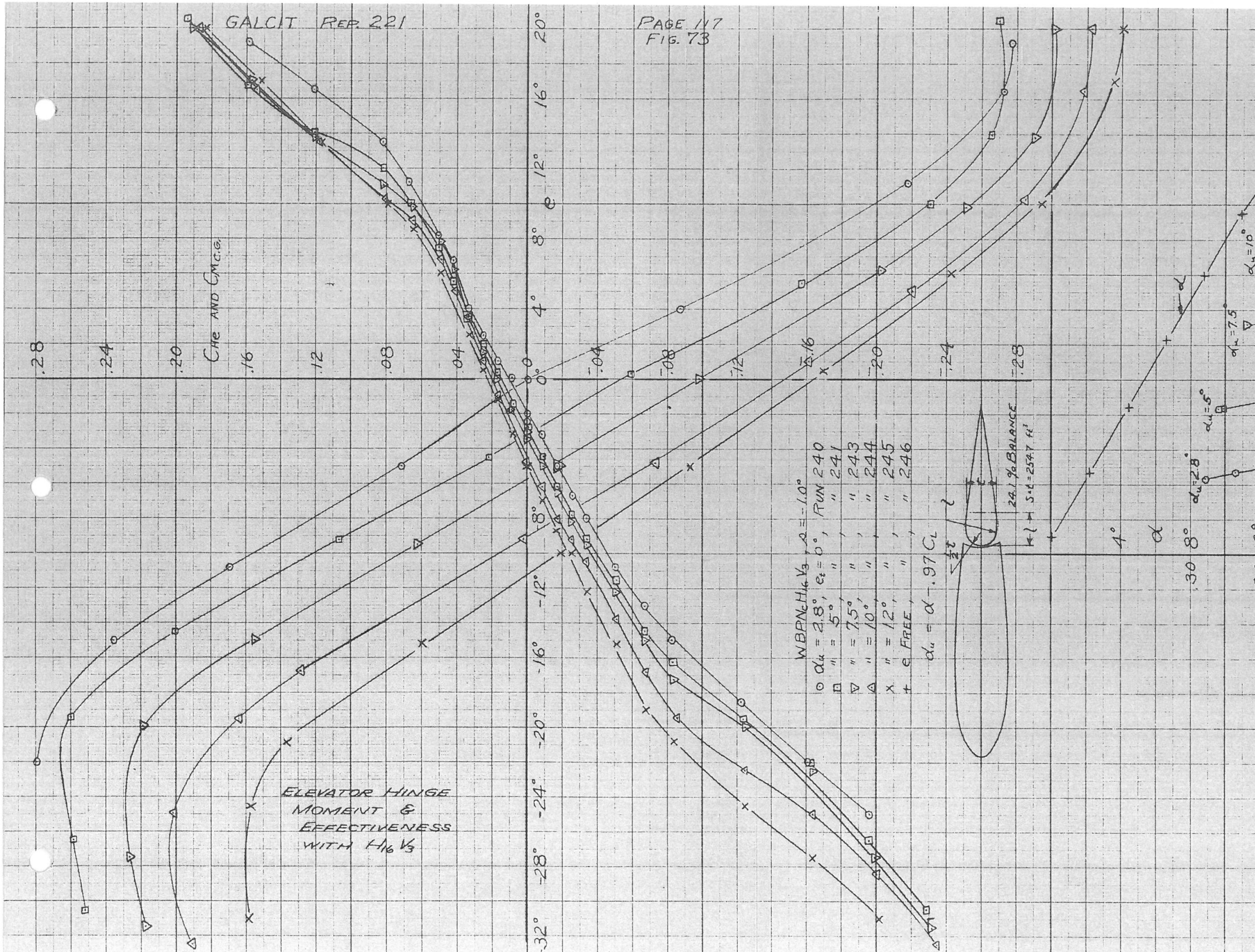
GALCIT REP 221

PAGE 116
FIG 72

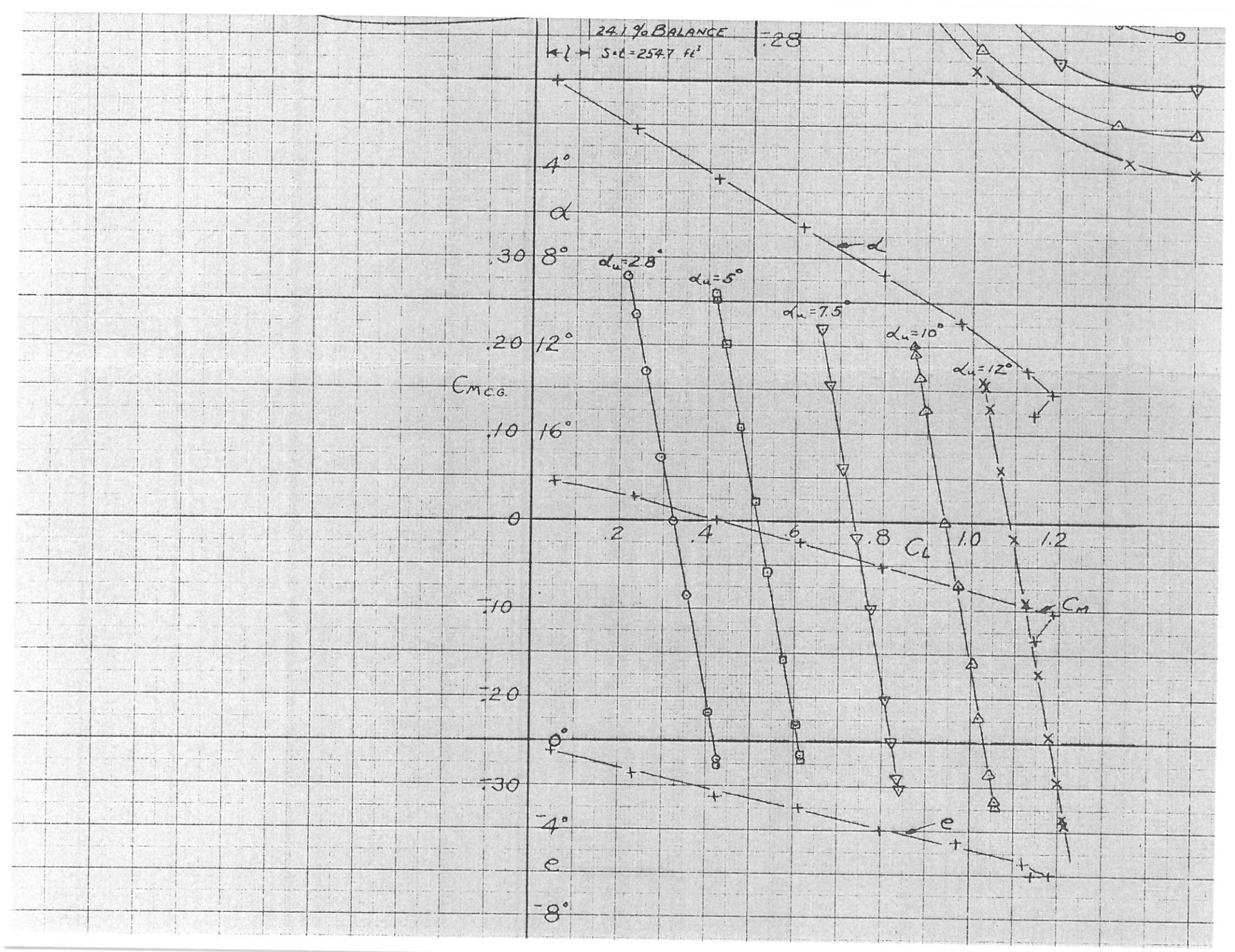


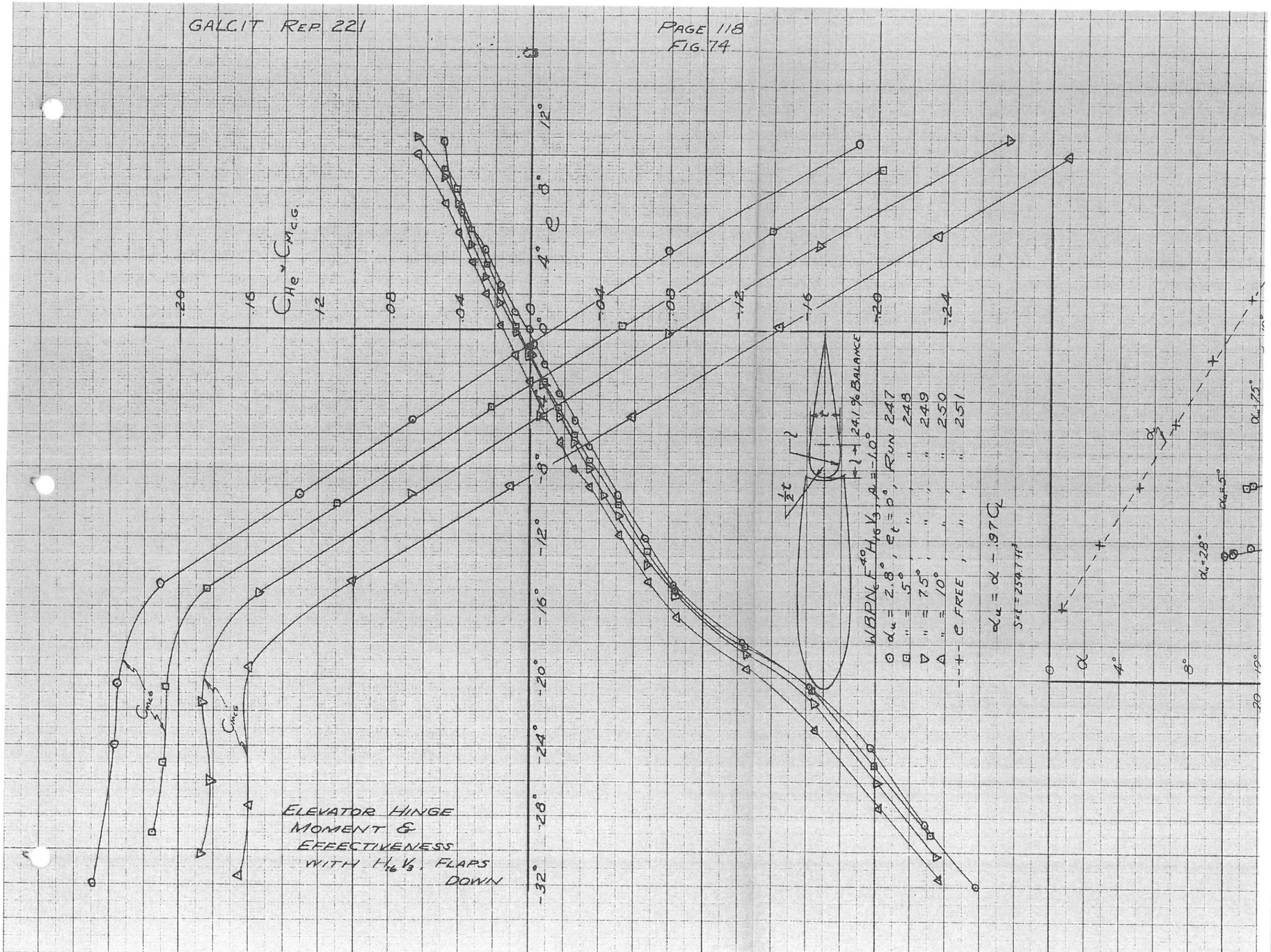
ELEVATOR HINGE MOMENT & EFFECTIVENESS
WITH $H_{1.5}$ V_3


.28
-.30
.30
.20
$C_{m_{c/4}}$
.10
0
-.10
-.20
-.30
$\alpha_w = 2.8°$
5°
7.5°
10°
12°
0
.2
.4
.6
.8
1.0
1.2
C_L

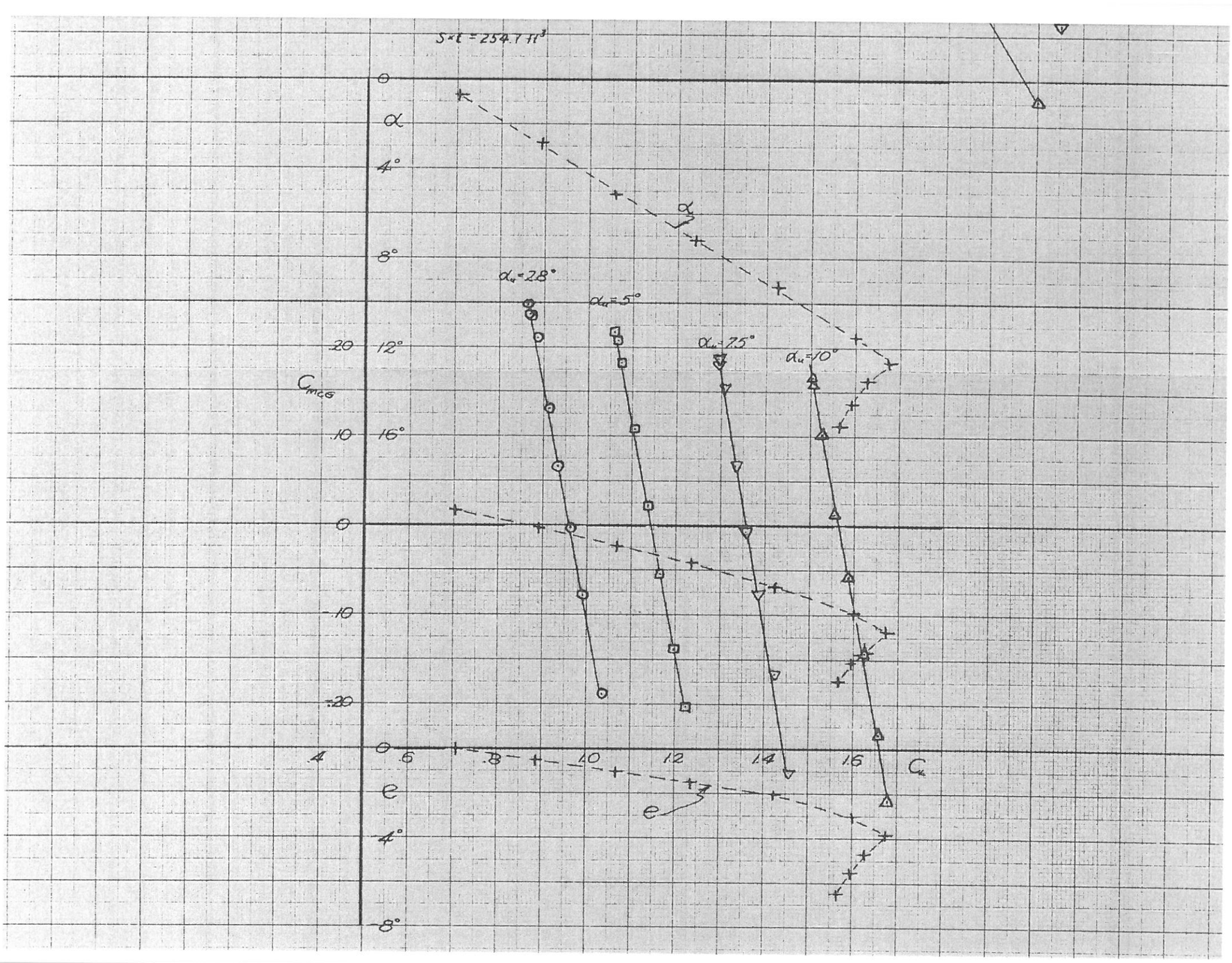


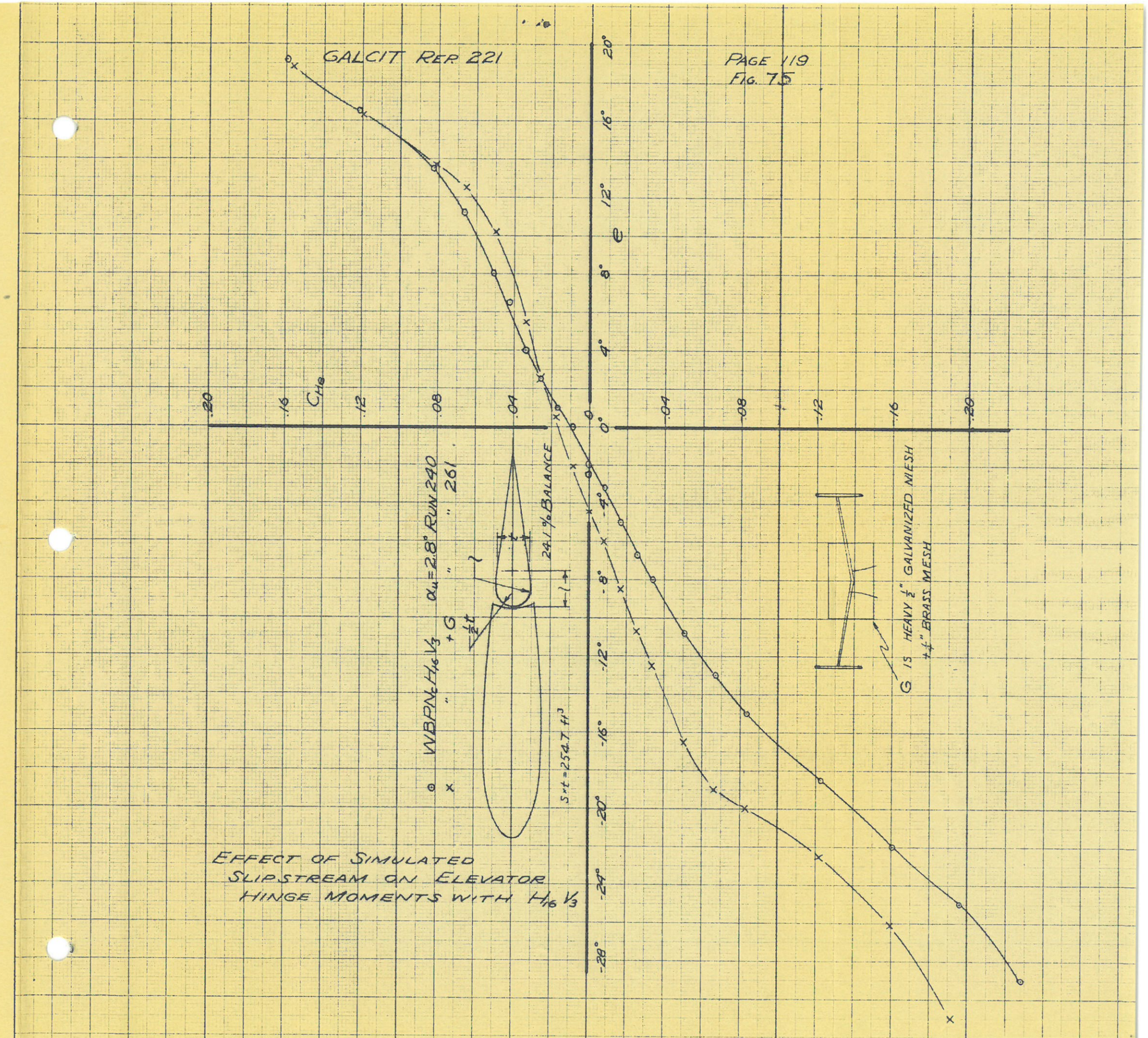
ELEVATOR HINGE MOMENT & EFFECTIVENESS WITH H_{16} V_3


24.1% BALANCE
S·L = 254.7 ft²
.28
4°
α
8°
12°
16°
$C_{M_{C.G.}}$
.30
.20
.10
0
-.10
-.20
-.30
0°
-4°
e
-8°
$\alpha_u = 2.8°$
$\alpha_u = 5°$
$\alpha_u = 7.5°$
$\alpha_u = 10°$
$\alpha_u = 12°$
.2
.4
.6
.8
C_L
1.0
1.2
C_m

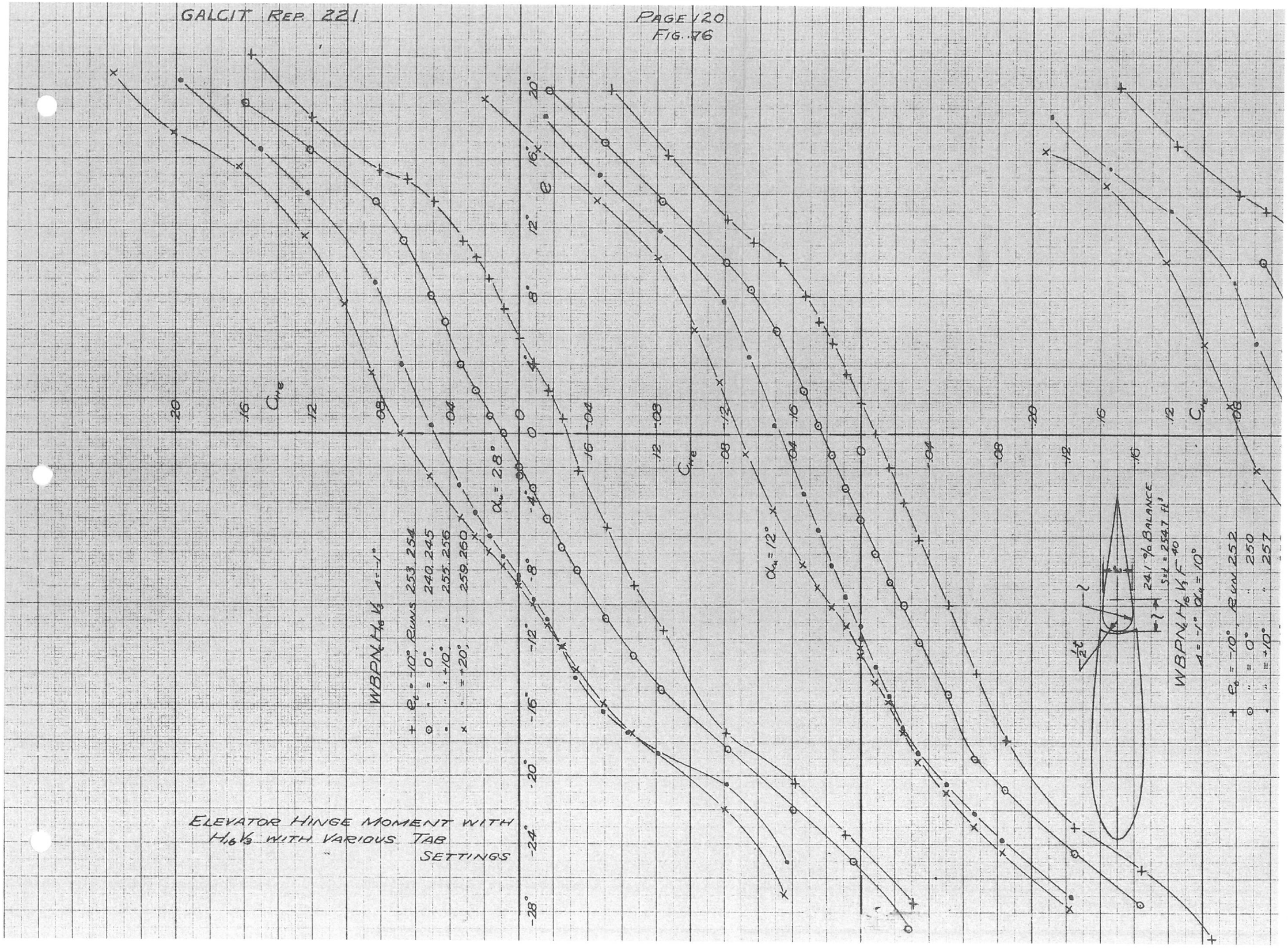


ELEVATOR HINGE MOMENT & EFFECTIVENESS WITH $H_{16} V_3$ FLAPS DOWN

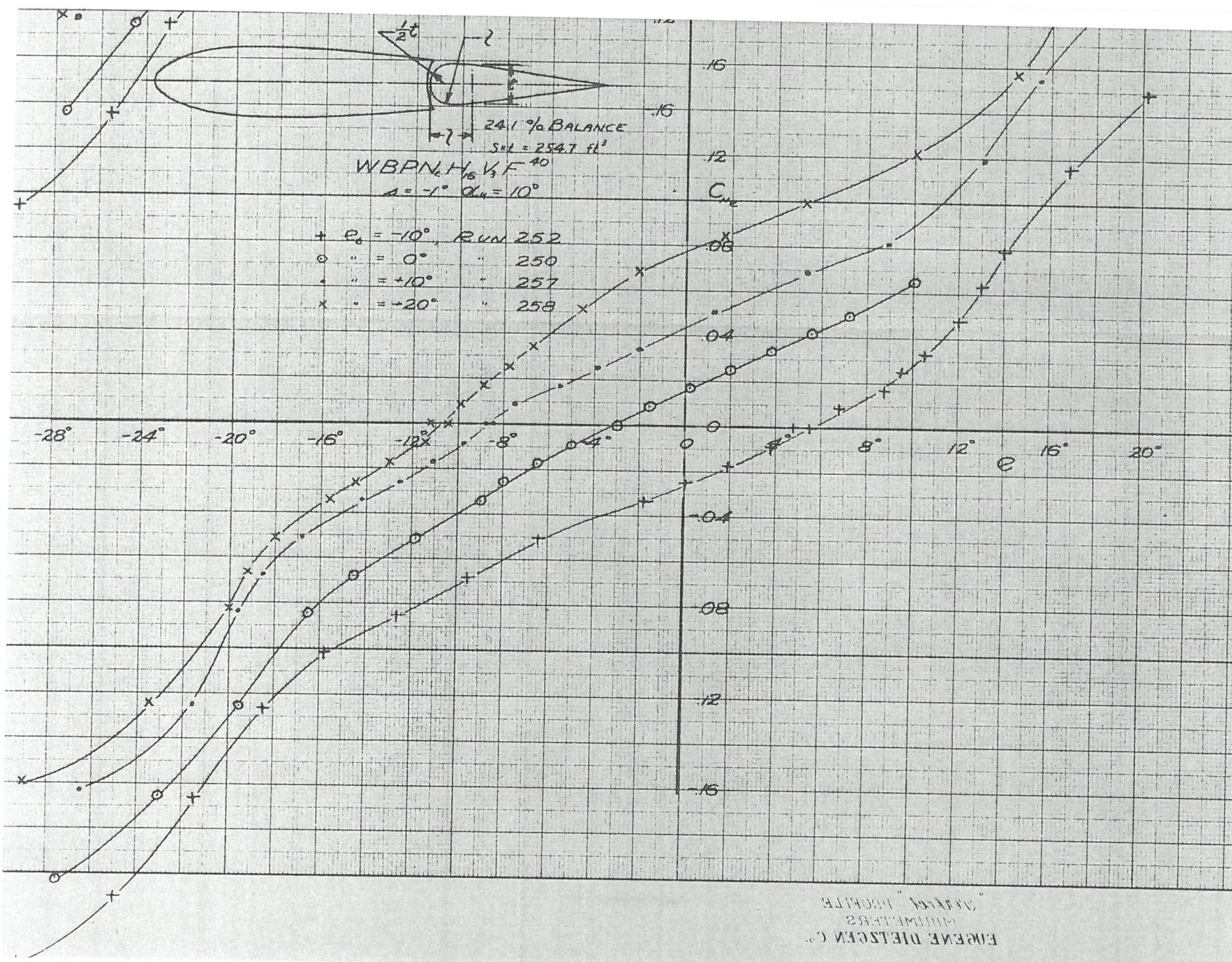

S·ℓ = 254.7 м³
α
4°
8°
12°
16°
C_{mcs}
.20
.10
0
-.10
-.20
α_u=2.8°
α_u=5°
α_u=7.5°
α_u=10°
.4
0
.6
.8
1.0
1.2
1.4
1.6
C_u
e
4°
8°



EFFECT OF SIMULATED SLIPSTREAM ON ELEVATOR HINGE MOMENTS WITH H_{16} V_3



ELEVATOR HINGE MOMENT WITH $H_6 1/3$ WITH VARIOUS TAB SETTINGS



1/2 t
24.1 % BALANCE
S = 254.7 ft³
WBPN H16 V3 F40
α = -1° αH = 10°
+ e = -10°, RUN 252
⊙ " = 0° " 250
• " = +10° " 257
x " = +20° " 258
C
e
-28° -24° -20° -16° -12° -8° -4° 0 4° 8° 12° 16° 20°
.16 .12 .08 .04 0 -.04 -.08 -.12 -.16

GALCIT REP 221

PAGE 121
FIG 77

ELEVATOR HINGE MOMENT AND EFFECTIVENESS WITH H_{18} V_4

C_{H_δ} AND C_M

.24
.20
.16
.12
.08
.04
0
-.04
-.08
-.12
-.16
-.20
-.24
-.28

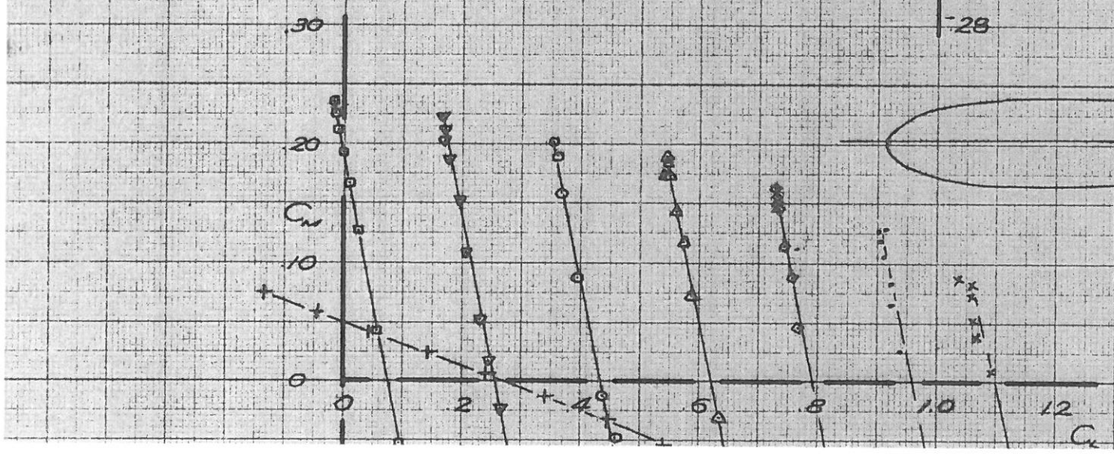
-28° -24° -20° -16° -12° -8° -4° 0 4° 8° 12° 16°

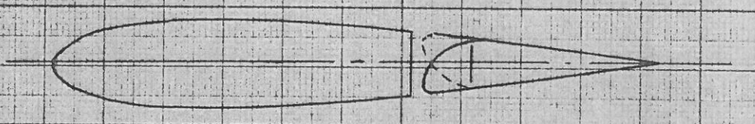
δ

WB. PN. H_{18} V_4, $\Lambda = 1$; $\delta_t = 0°$

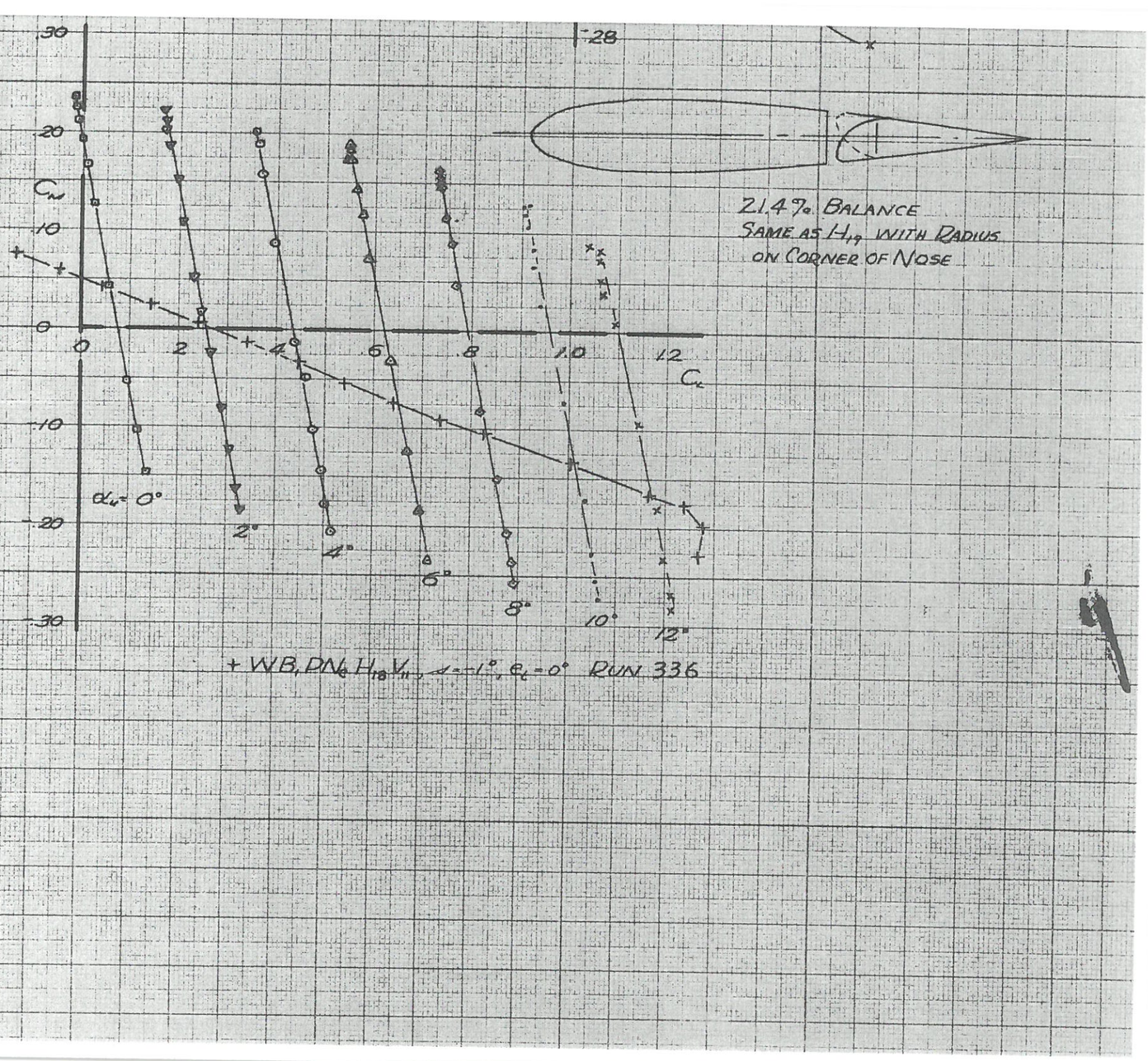
□	α_w = 0°,	RUN 343
▽	" 2°,	" 344
○	" 4°,	" 345
△	" 6°,	" 346
◇	" 8°,	" 347
·	" 10°,	" 348
×	" 12°,	" 340

$S \times t = 254.7$ ft^3



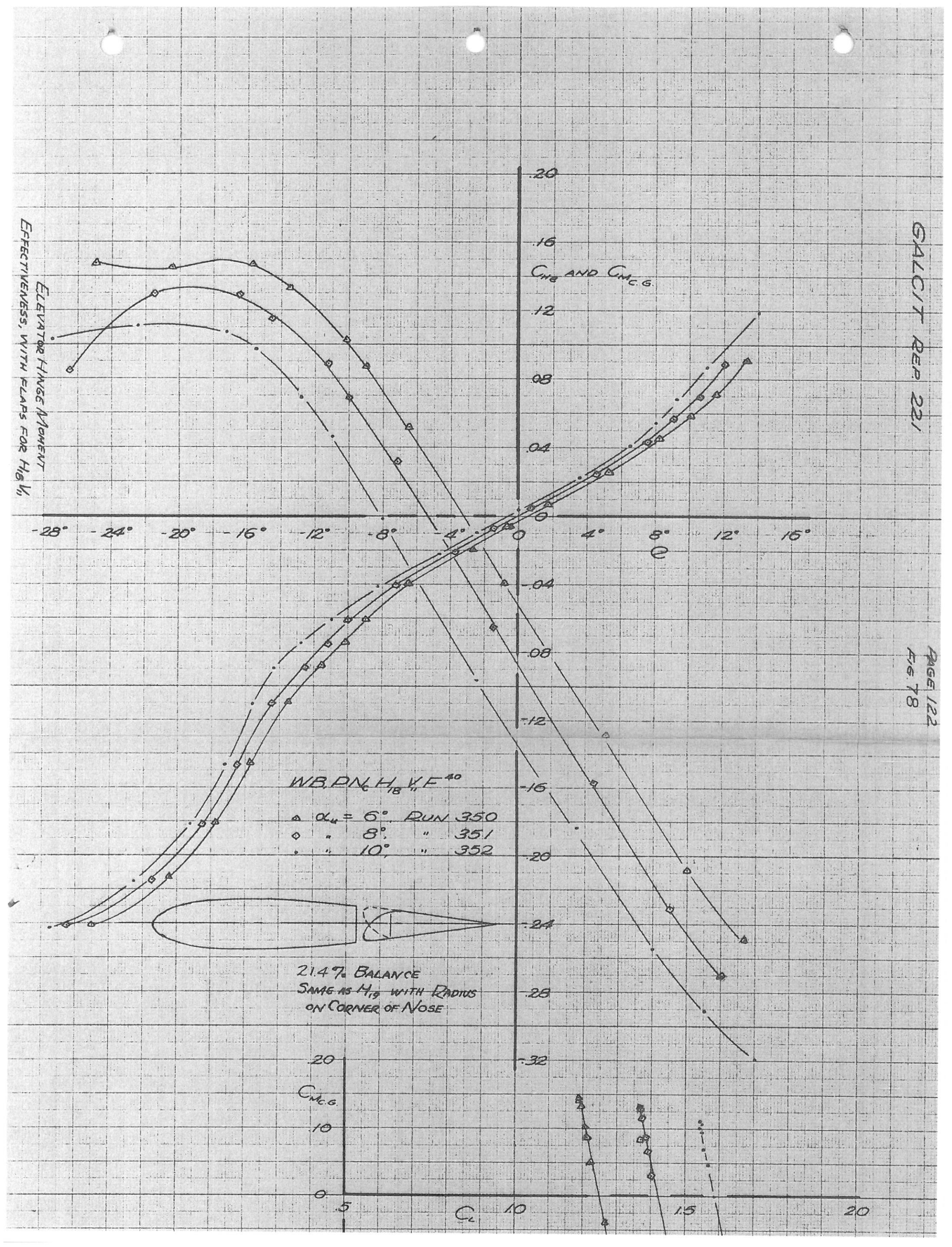


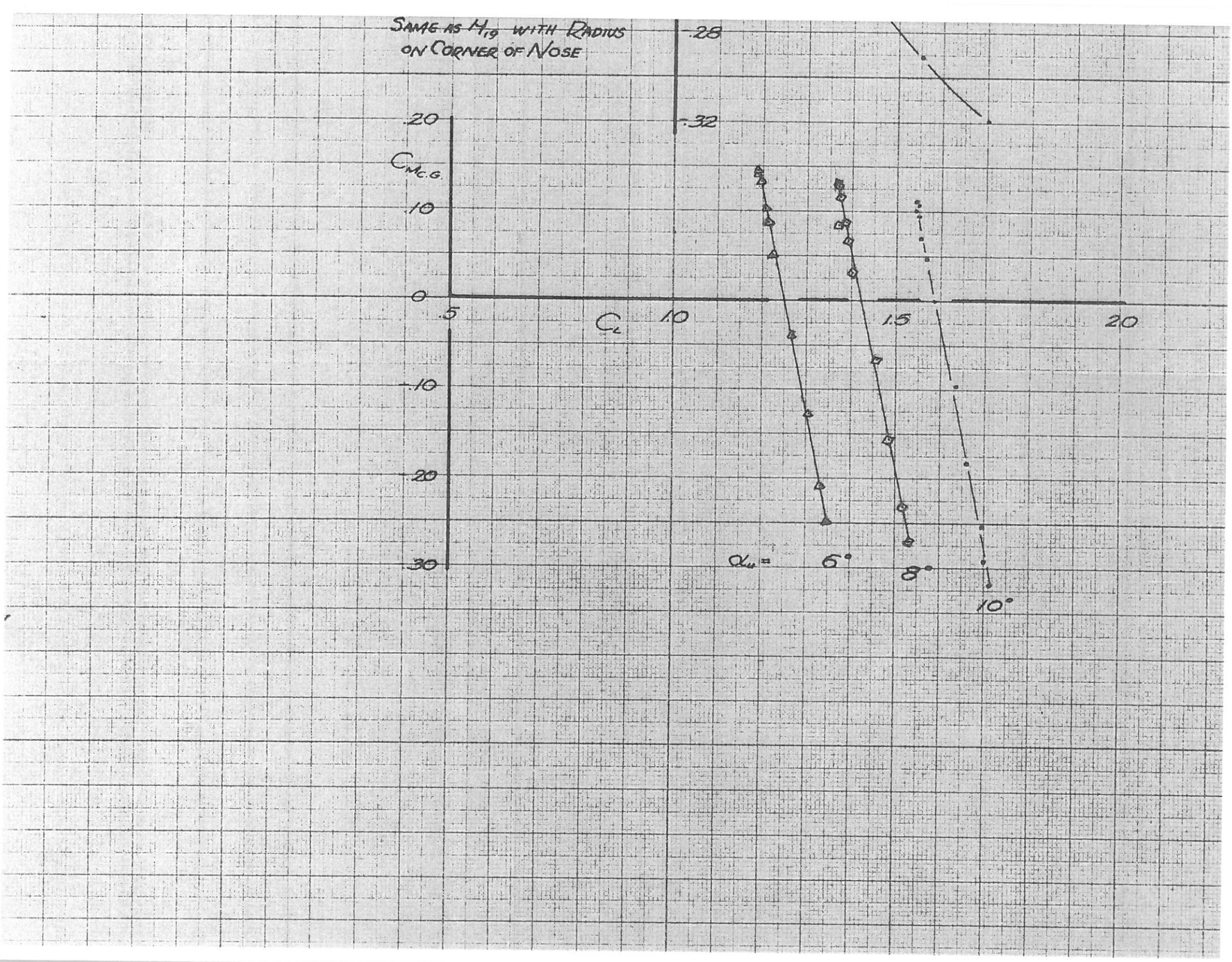
21.4% BALANCE
SAME AS H_{19} WITH RADIUS
ON CORNER OF NOSE

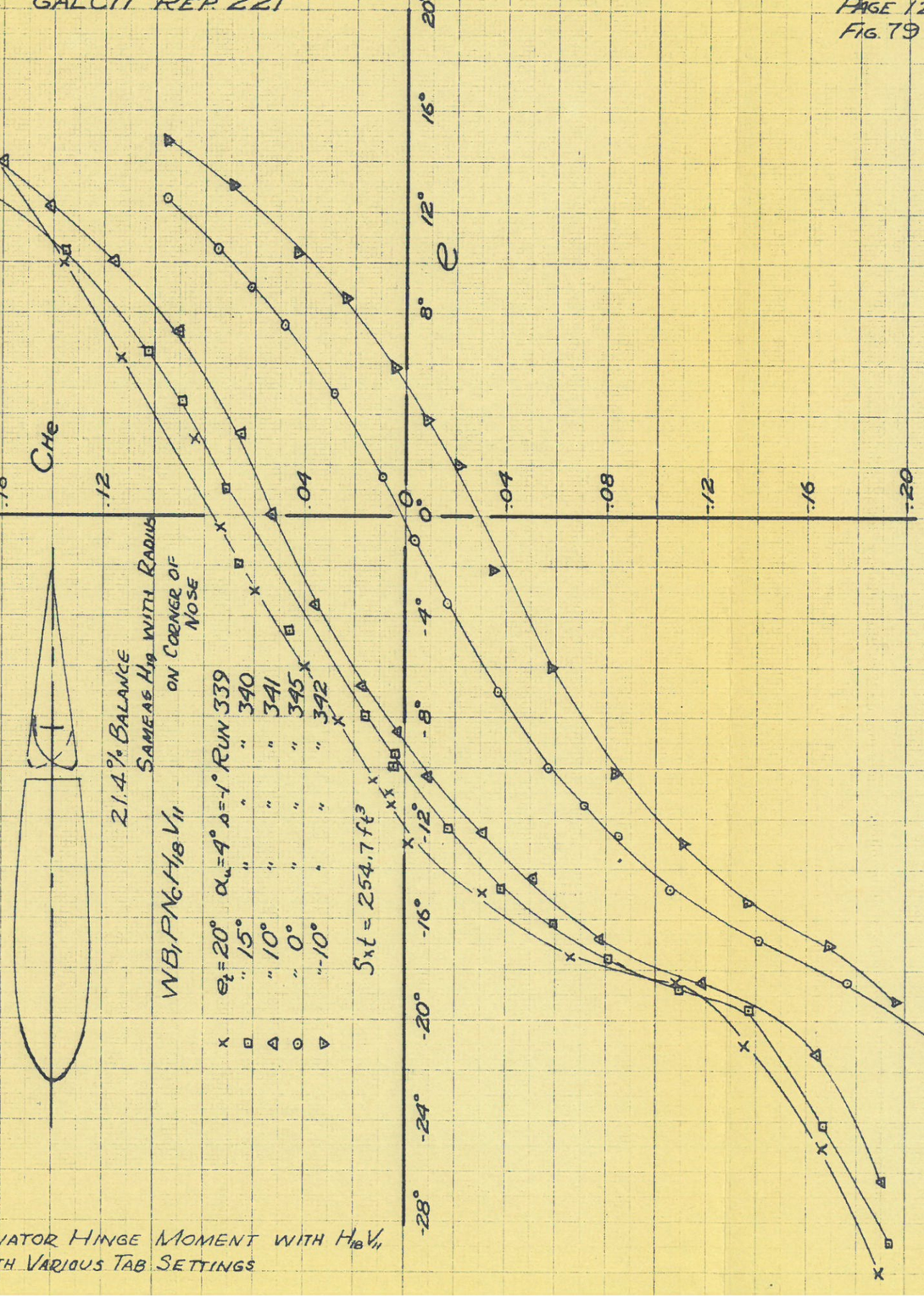


21.4% BALANCE
SAME AS H_{19} WITH RADIUS
ON CORNER OF NOSE

+ WB, PN_6 H_{18} V_{11}, i = -1°, ϵ_t = 0° RUN 336


ELEVATOR HINGE MOMENT EFFECTIVENESS, WITH FLAPS FOR H_{18} V_{11}
C_{H_δ} AND $C_{M_{C.G.}}$
.20
.16
.12
.08
.04
0
-.04
-.08
-.12
-.16
-.20
-.24
-.28
-.32
-28° -24° -20° -16° -12° -8° -4° 0 4° 8° 12° 15°
α
WB. PN. H_{18} V_{11} F^{40}
△ α_t = 6° RUN 350
◇ " 8° " 351
○ " 10° " 352
21.4% BALANCE
SAME AS H_{19} WITH RADIUS ON CORNER OF NOSE
$C_{M_{C.G.}}$
.20
.10
0
.5
1.0
1.5
2.0
C_L

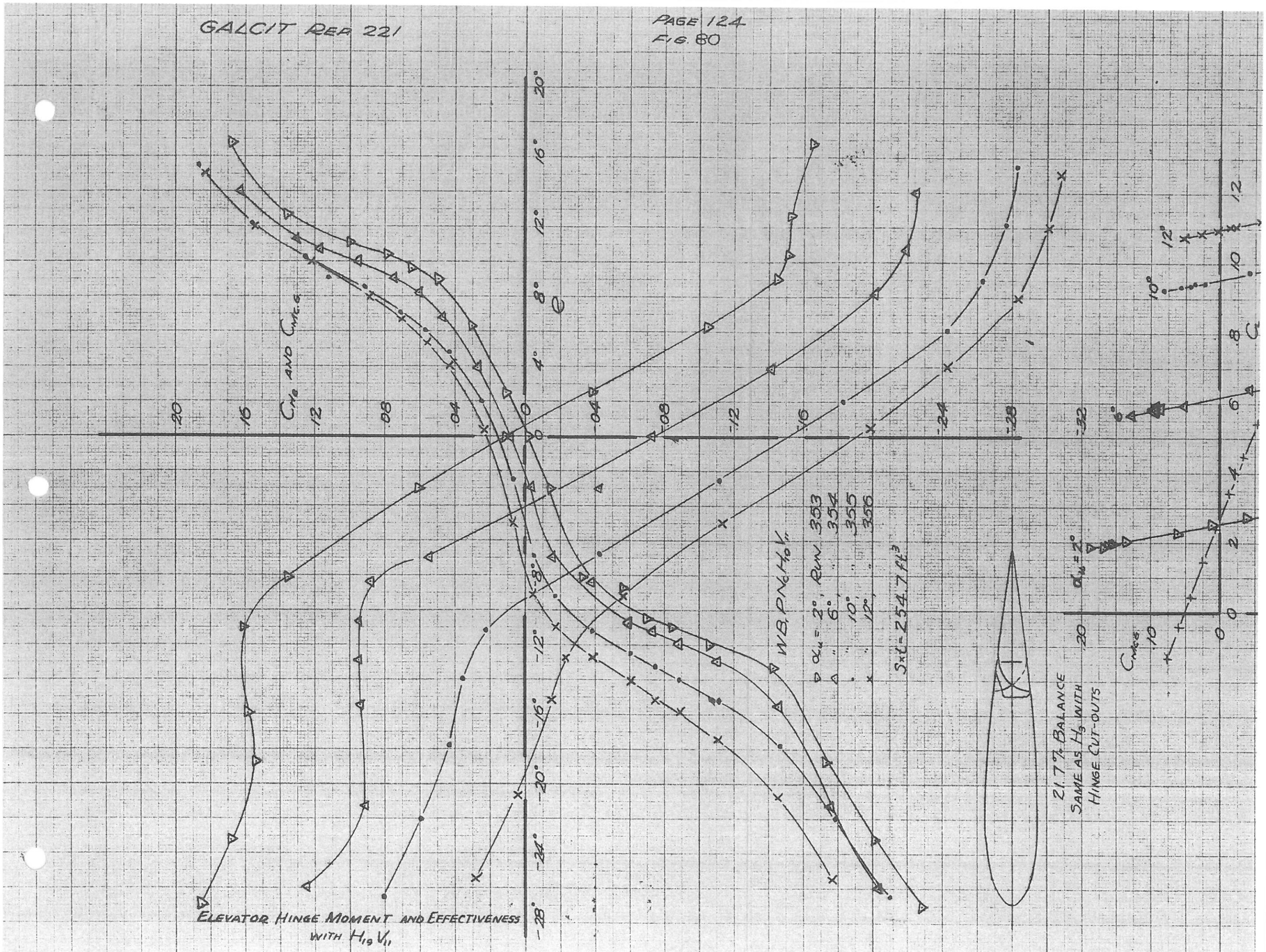

SAME AS H_{19} WITH RADIUS ON CORNER OF NOSE
.28
.32
.20
$C_{M_{C.G.}}$
.10
0
.5
C_L
1.0
1.5
2.0
-.10
-.20
-.30
α_w =
6°
8°
10°



ELEVATOR HINGE MOMENT WITH $H_{18}V_{11}$
WITH VARIOUS TAB SETTINGS

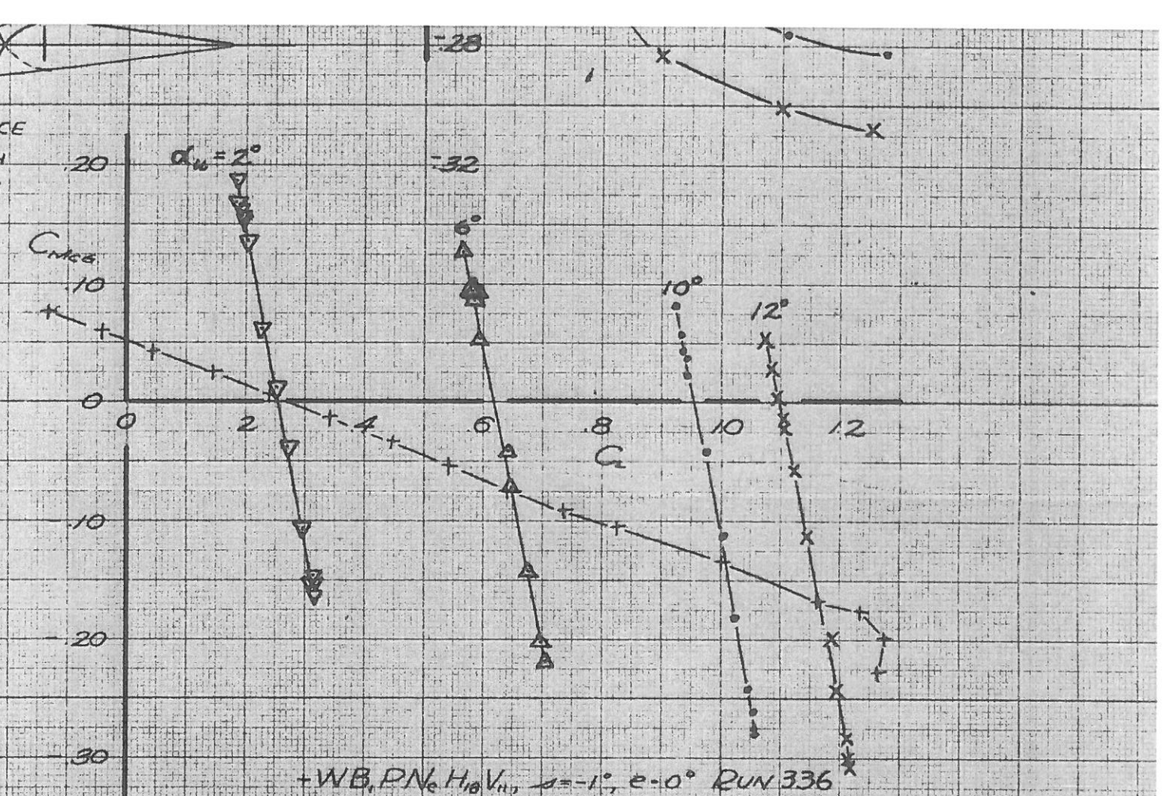
GALCIT AER 221

PAGE 124
FIG. 80

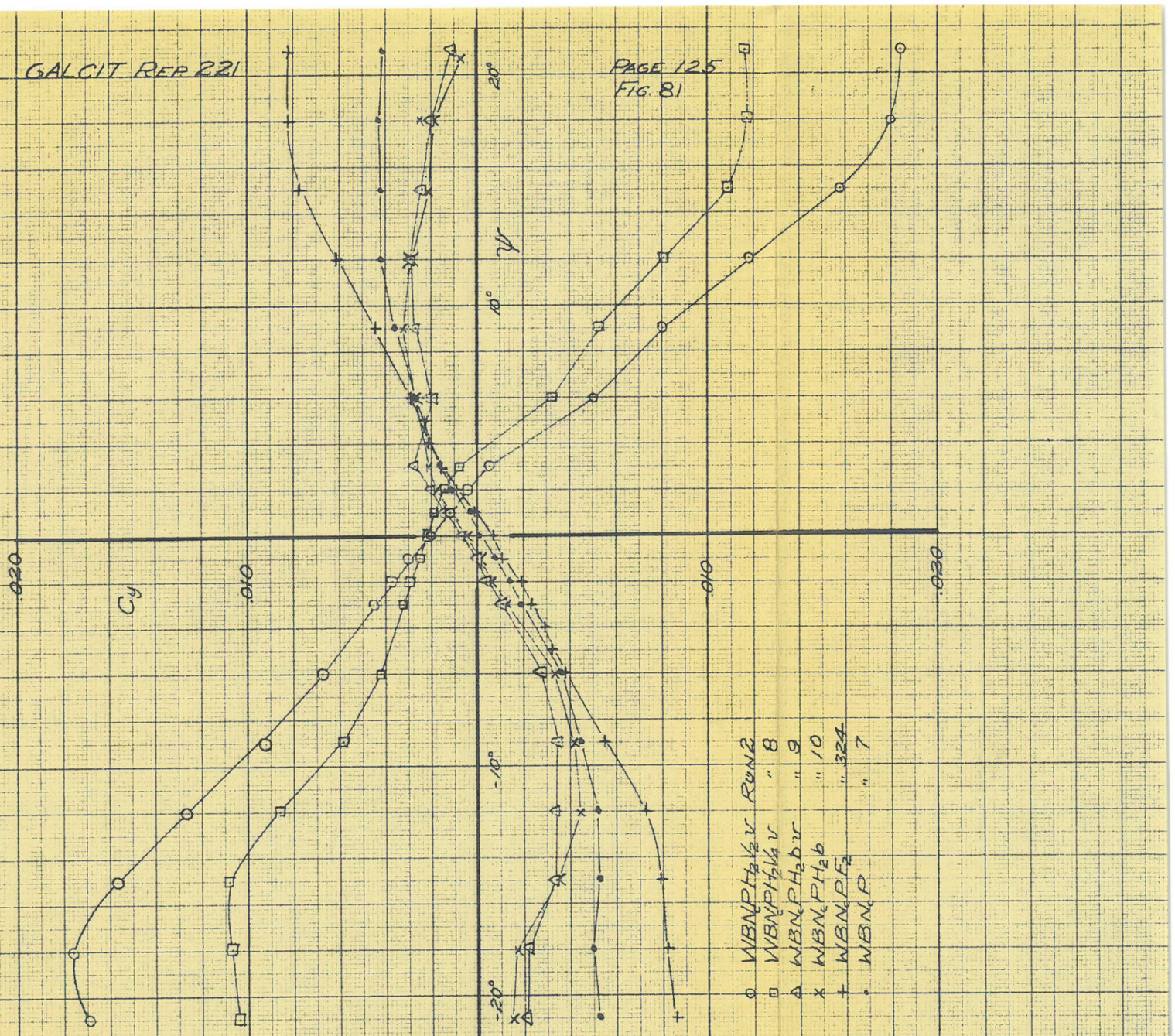


ELEVATOR HINGE MOMENT AND EFFECTIVENESS WITH H_{19} V_{11}

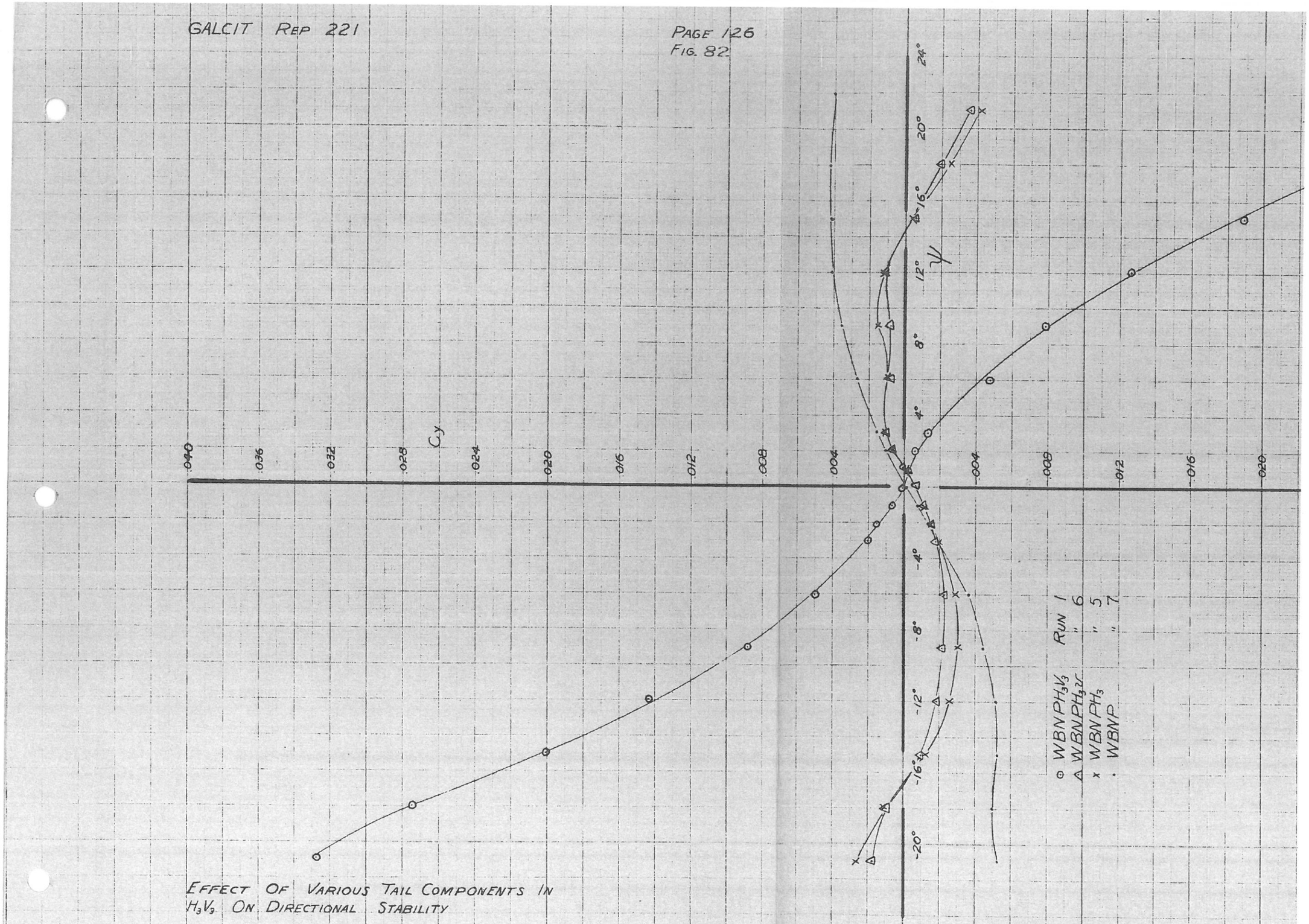
21.7% BALANCE
SAME AS H_3 WITH
HINGE CUT-OUTS



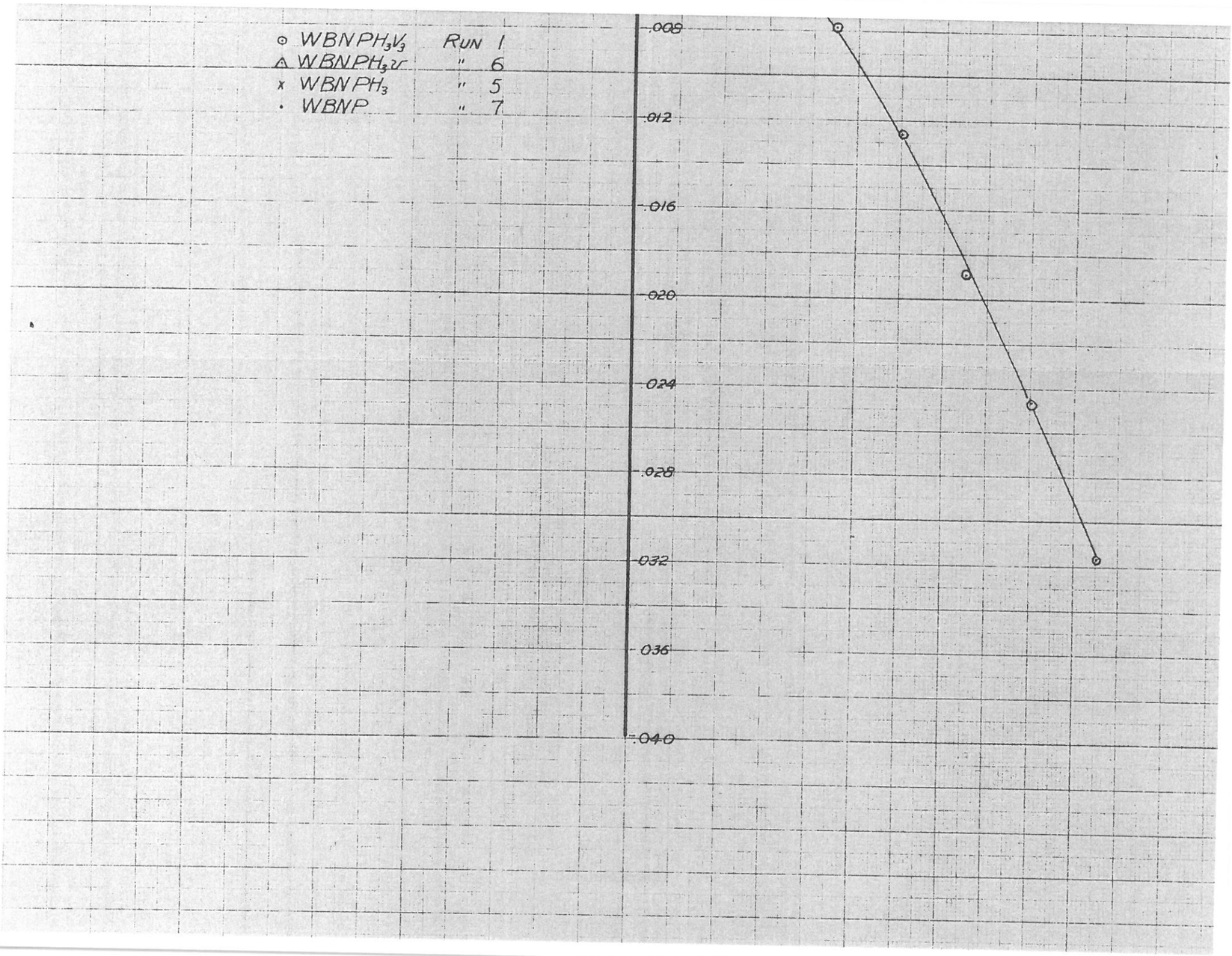
+WB, PN, H_{i0} V_{H_3}, i_t=-1°, e-0° RUN 336

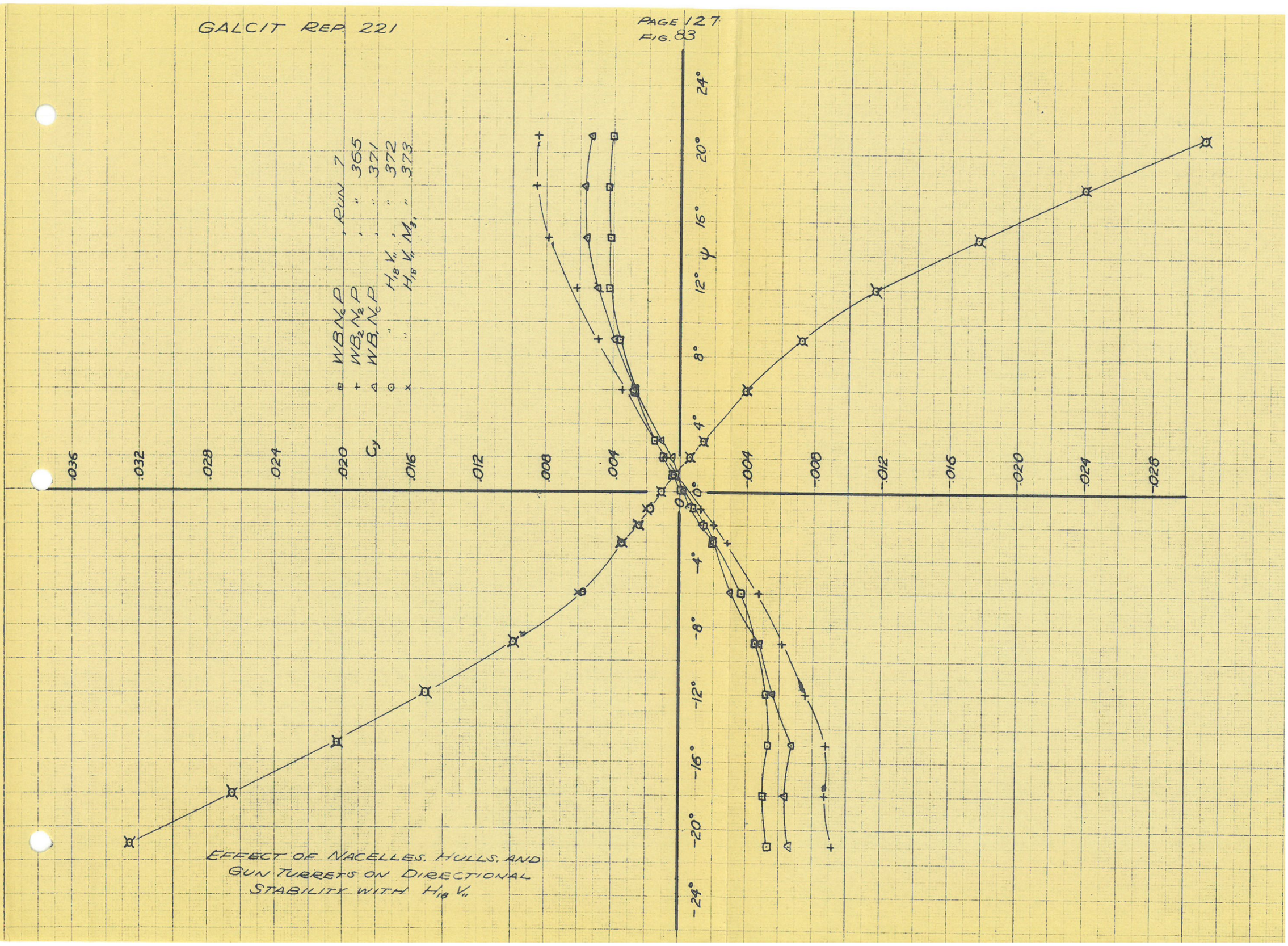


EFFECTS OF VARIOUS TAIL COMPONENTS IN H_2V_2 ON DIRECTIONAL STABILITY

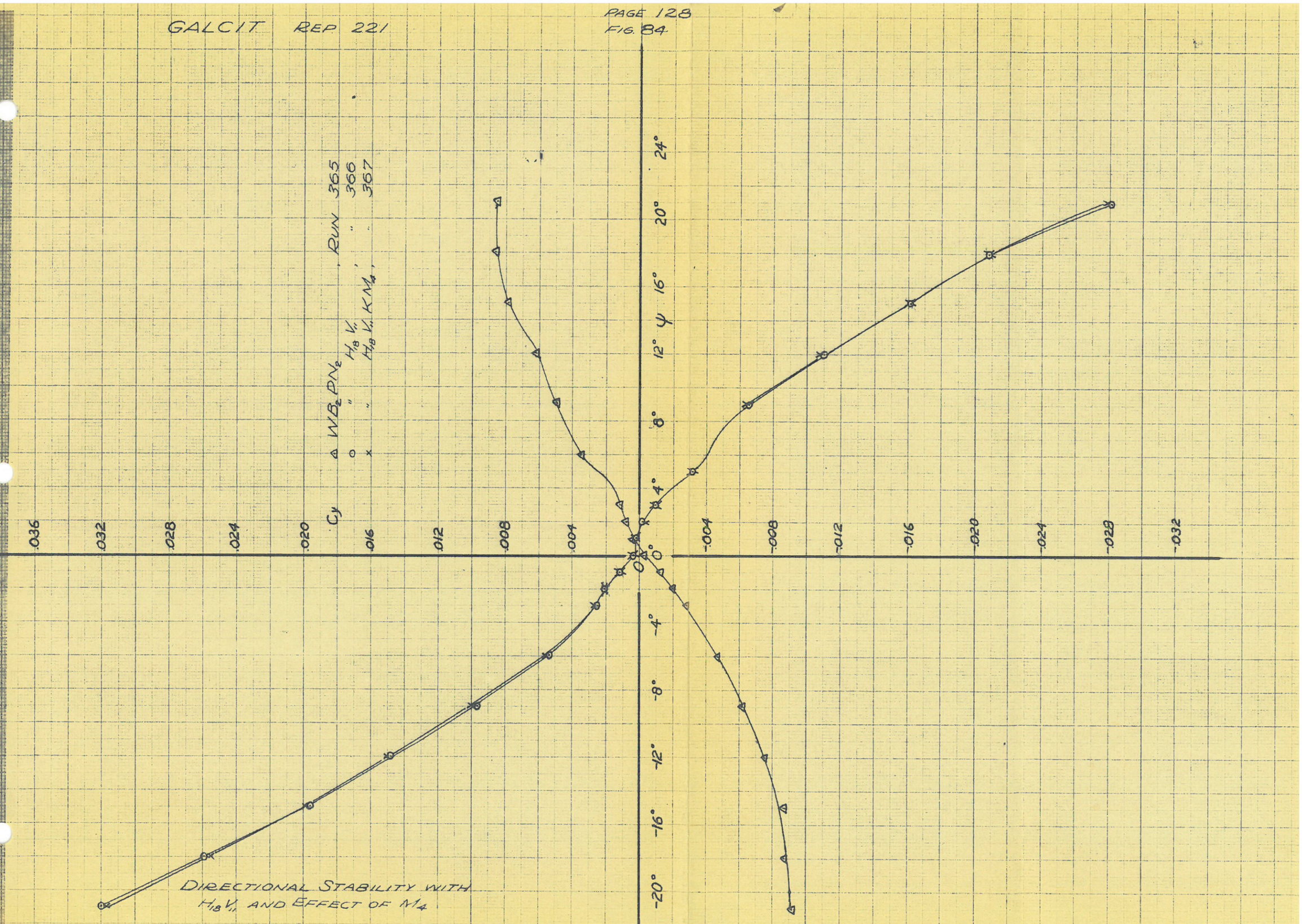


EFFECT OF VARIOUS TAIL COMPONENTS IN H_3V_3 ON DIRECTIONAL STABILITY

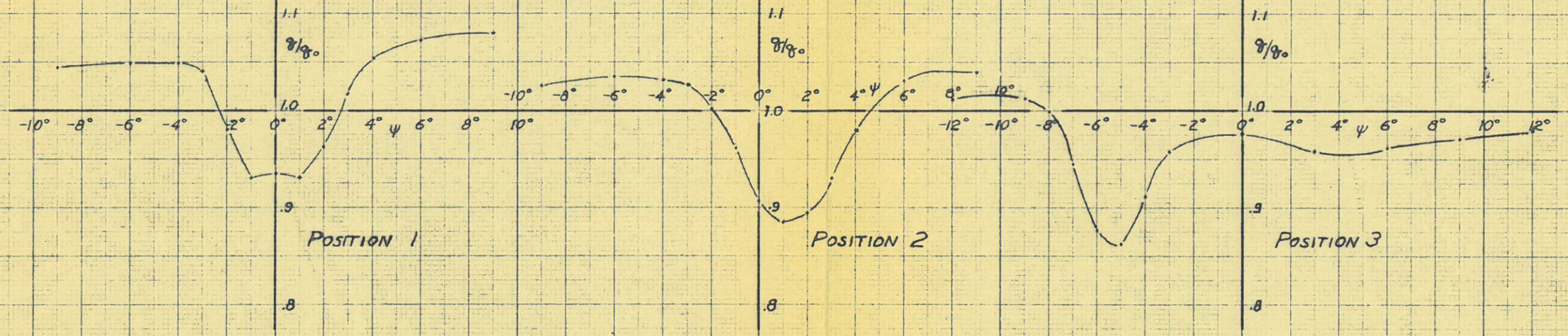

⊙ WBNPH3V3 RUN 1
△ WBNPH3V RUN 6
x WBNPH3 RUN 5
· WBNP RUN 7
.008
.012
.016
.020
.024
.028
.032
.036
.040

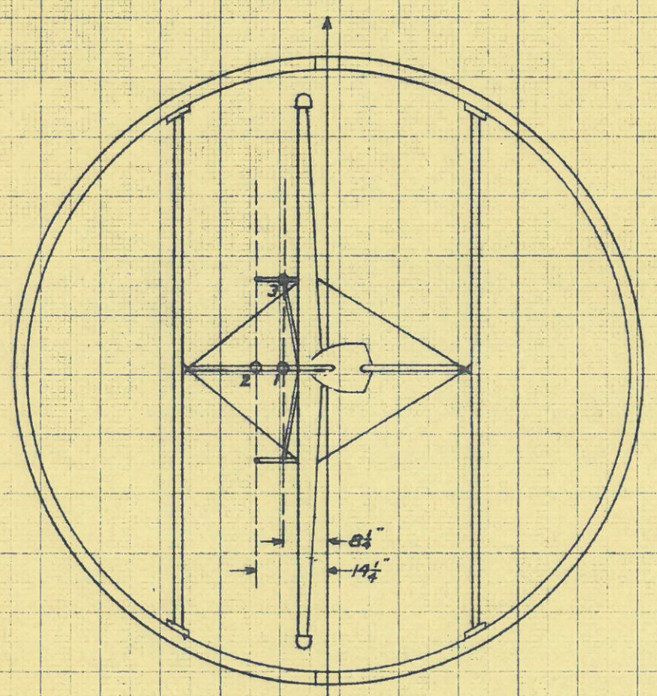


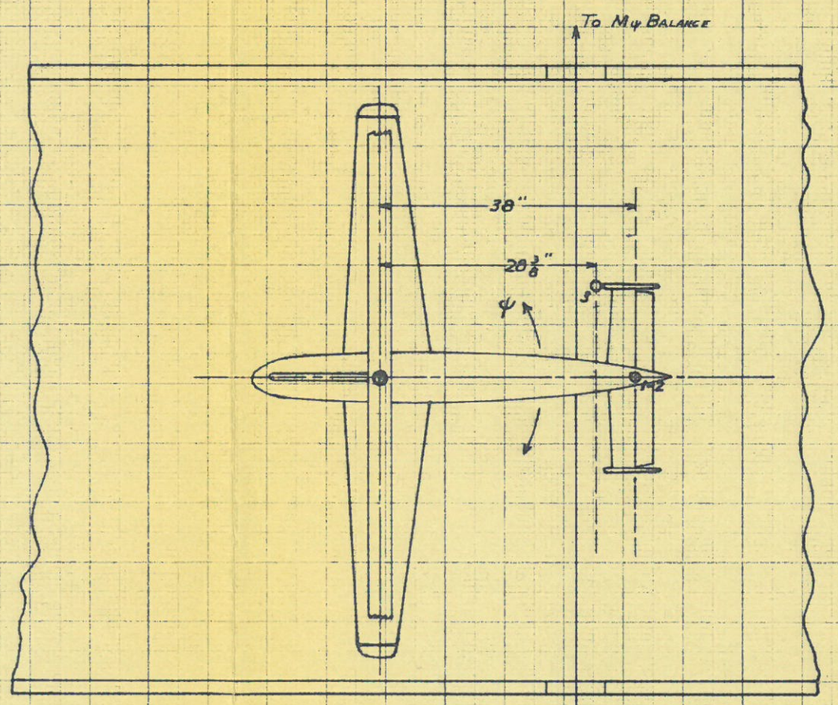
EFFECT OF NACELLES, HULLS, AND GUN TURRETS ON DIRECTIONAL STABILITY WITH H_{18} V_{11}



DIRECTIONAL STABILITY WITH $H_{18}V_{11}$ AND EFFECT OF M_4

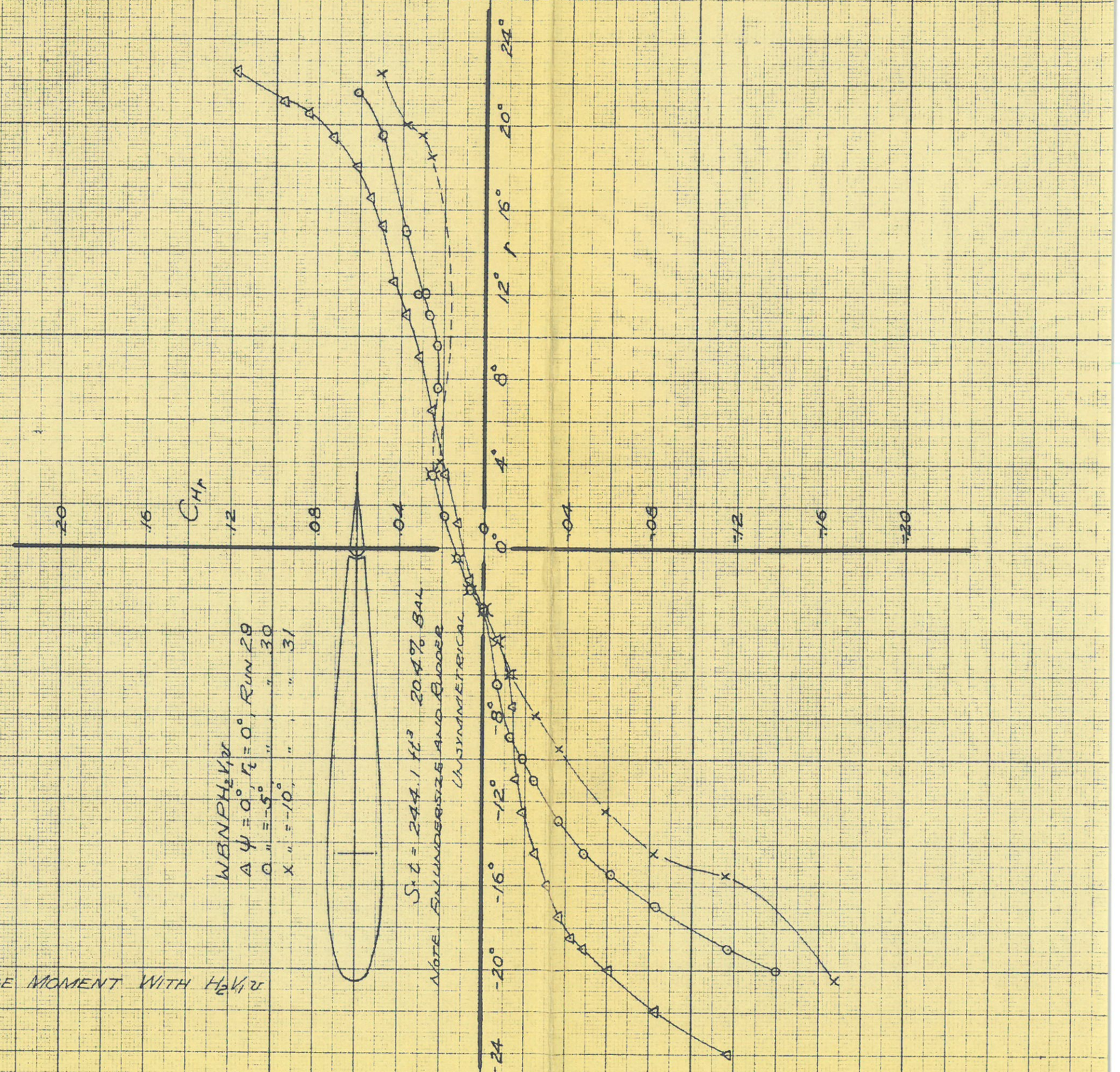






FOR POSITION 3 : WAKE CENTER = 13½" ABOVE TUNNEL HORIZONTAL ℄

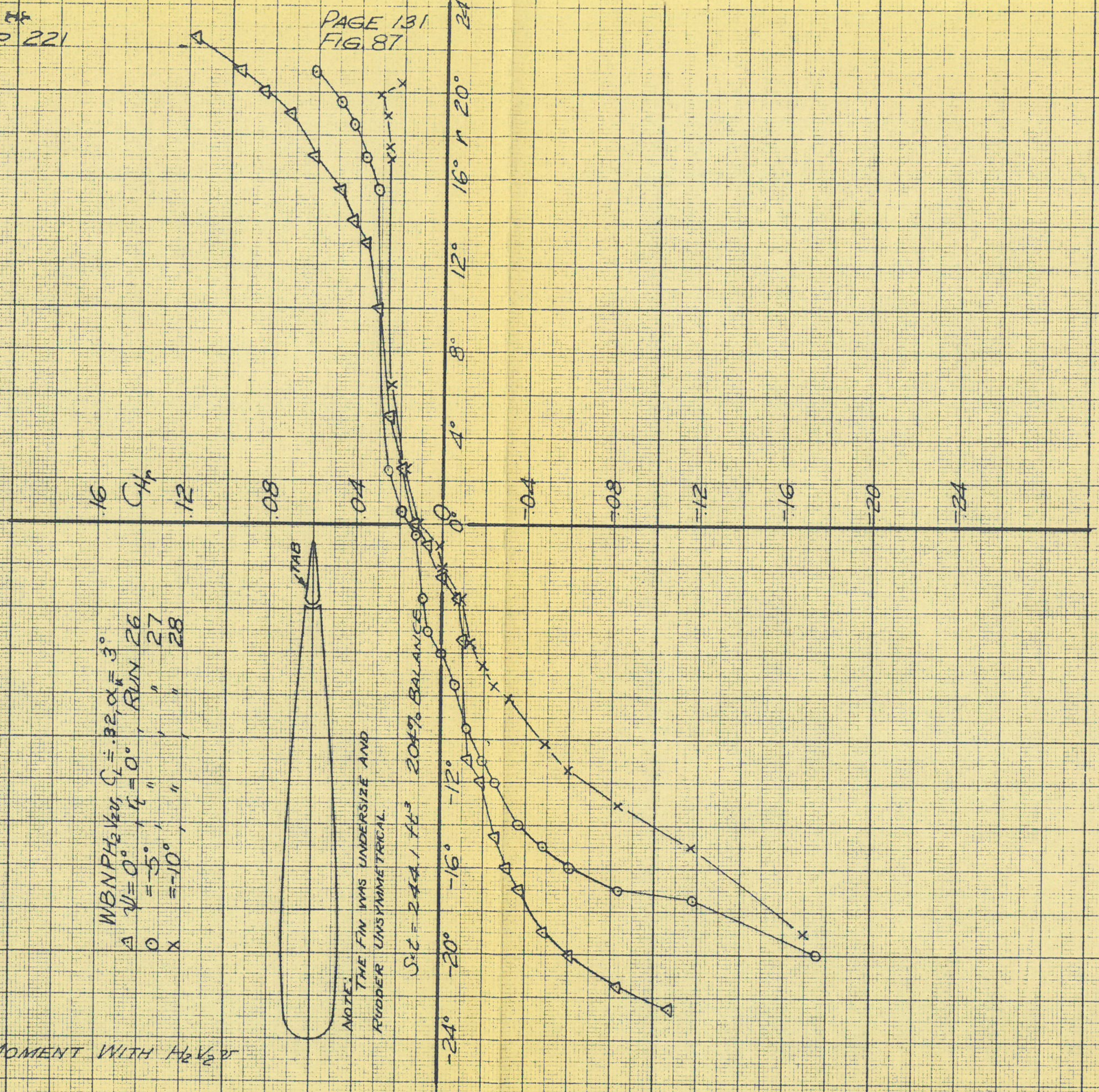
YAW RIGGING STRUTS AND WIRE WAKES IN THE VICINITY OF THE EMPENNAGE



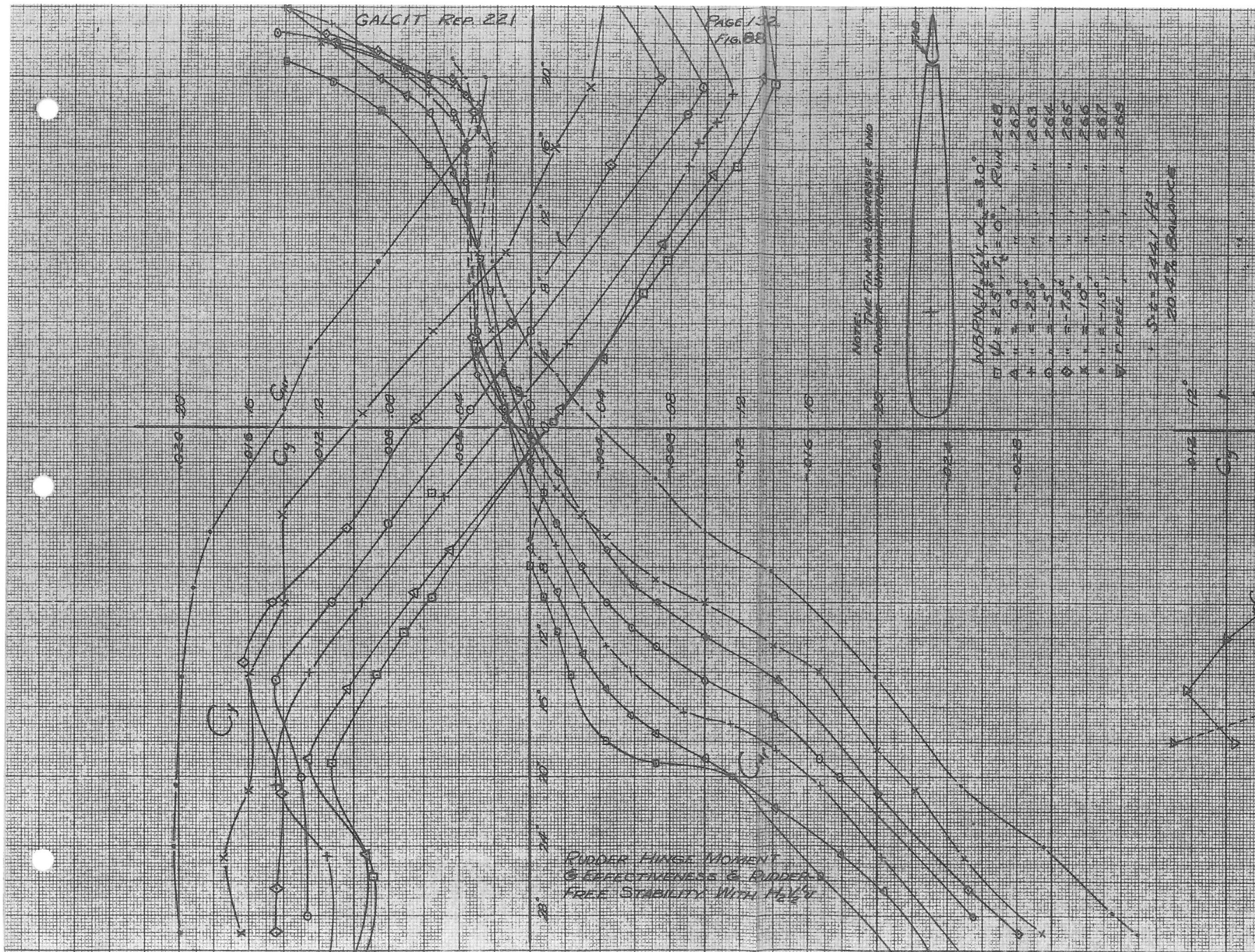
RUDDER HINGE MOMENT WITH H_2K_1R

GALCIT REP 221

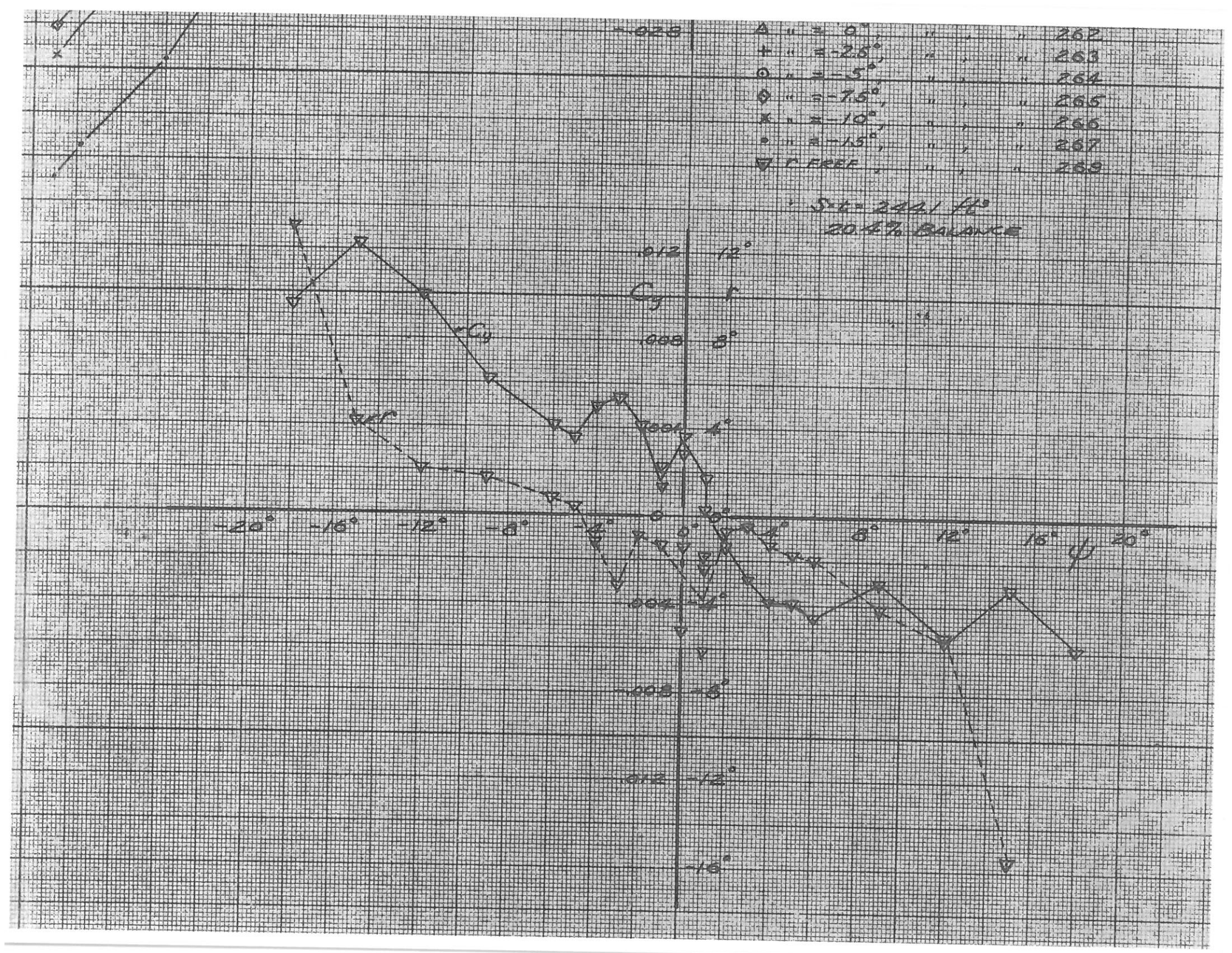
PAGE 131
FIG. 87

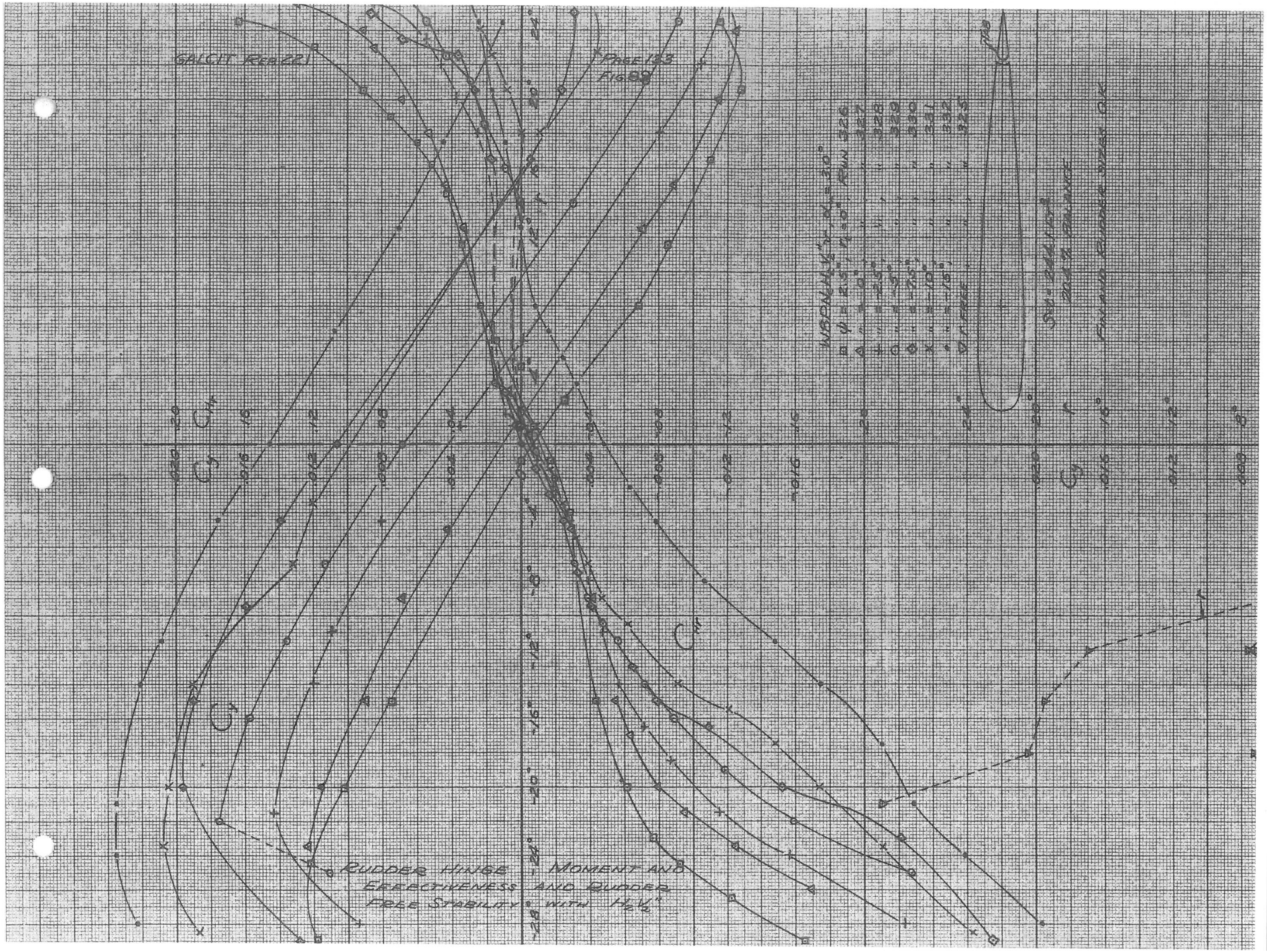


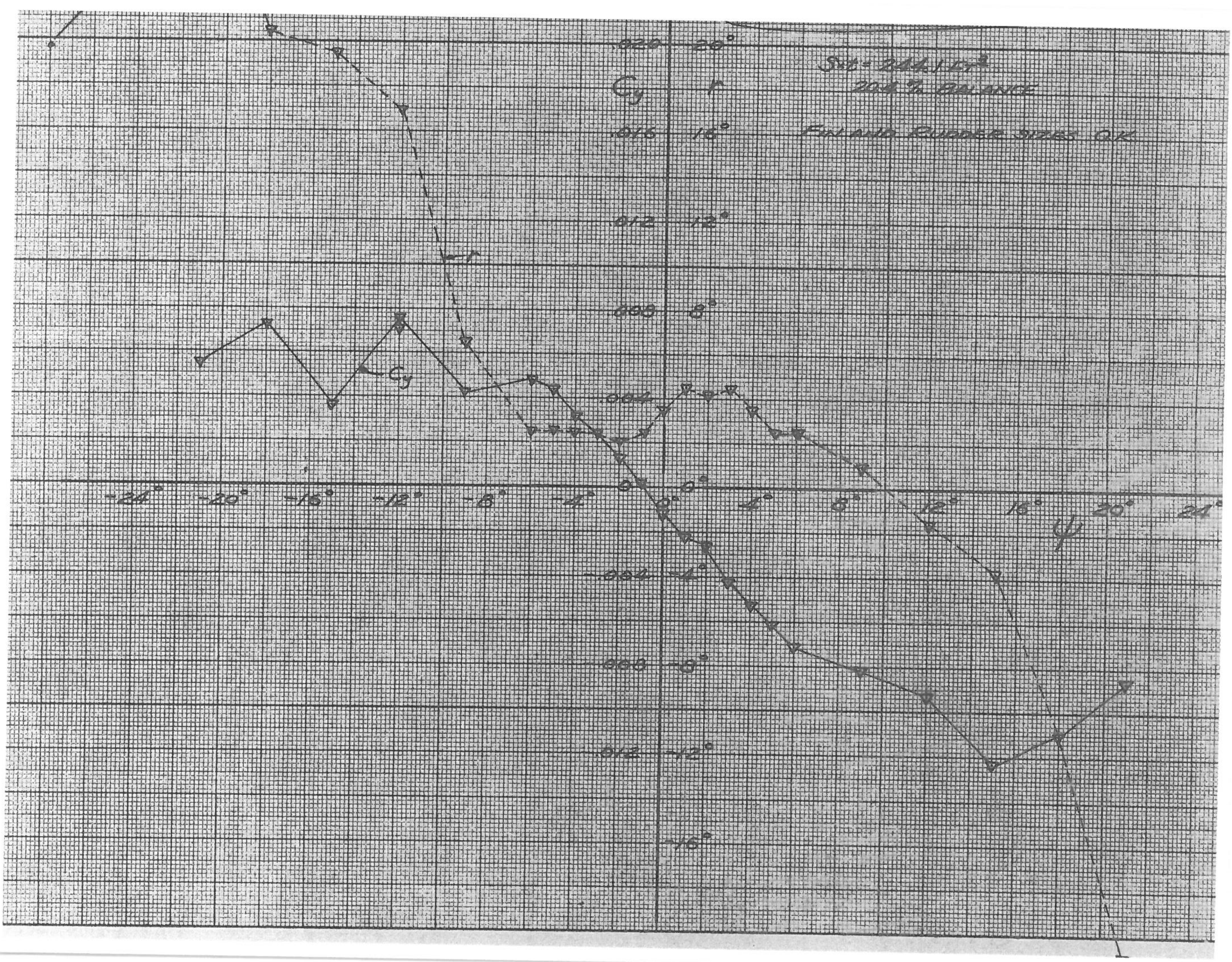
RUDDER HINGE MOMENT WITH H_2V_2

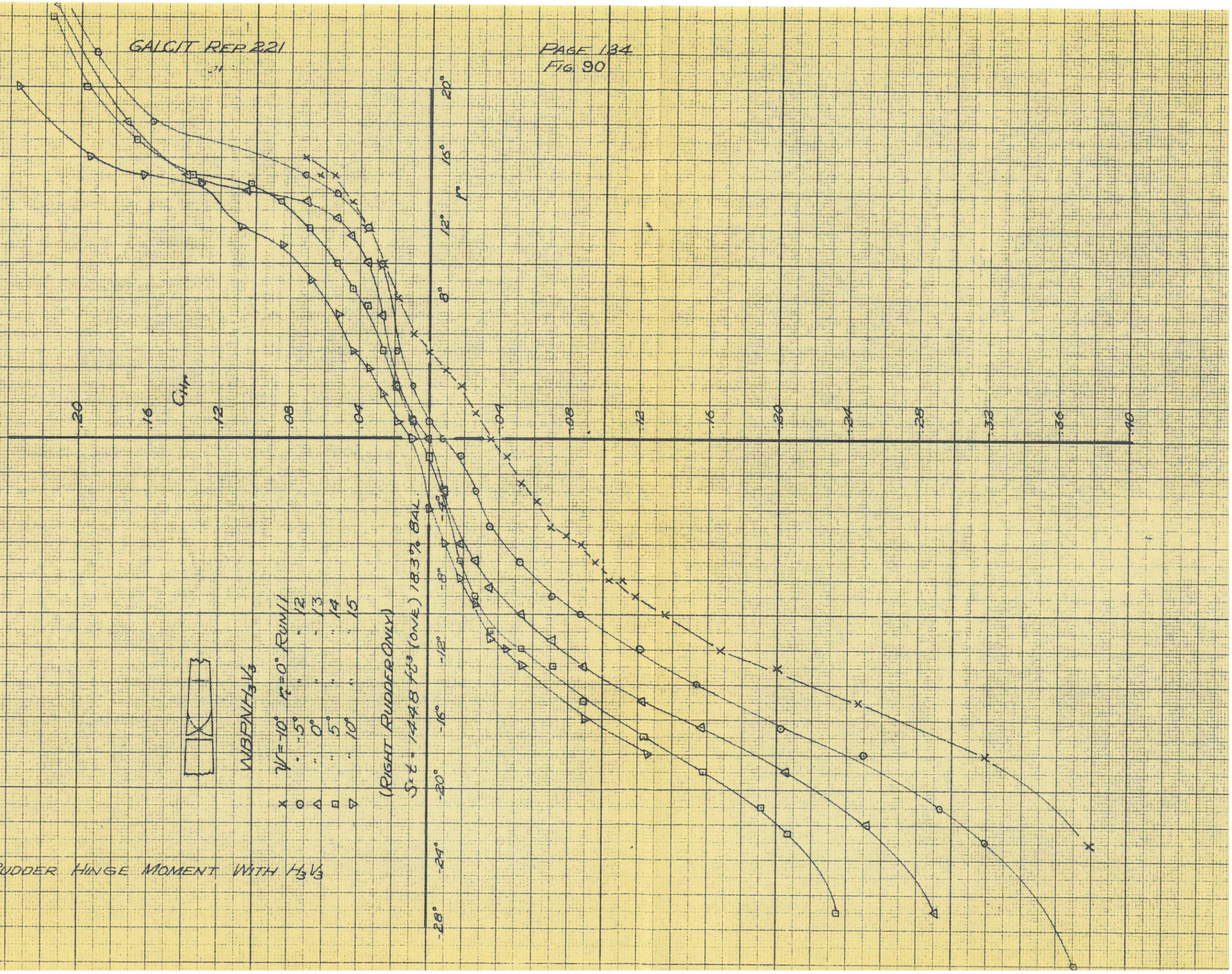


RUDDER HINGE MOMENT
& EFFECTIVENESS & RUDDER-
FREE STABILITY WITH $H_0V_2'r$

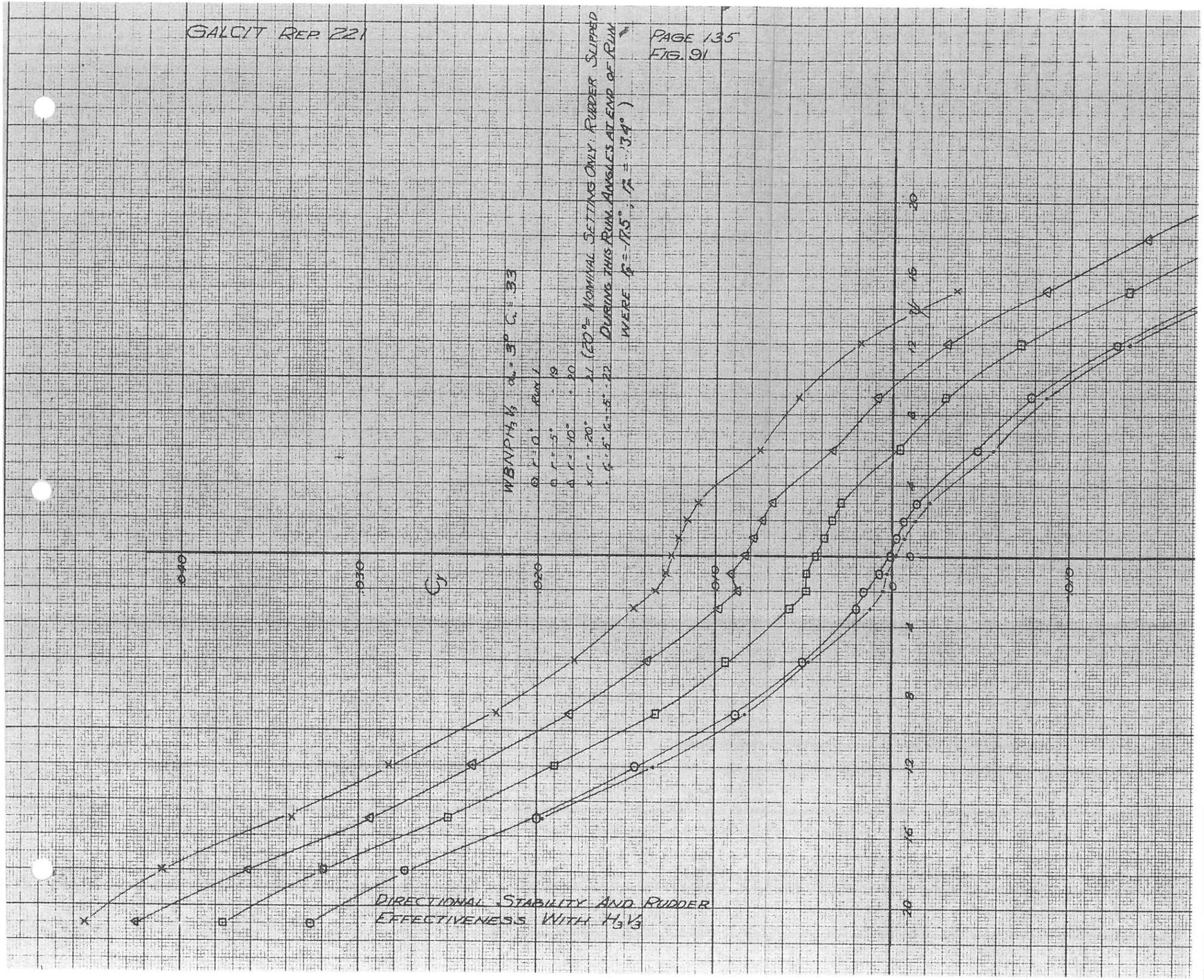

△ " = 0°, " " " 262
+ " = -2.5°, " " " 263
○ " = -5°, " " " 264
◇ " = -7.5°, " " " 265
× " = -10°, " " " 266
• " = -15°, " " " 267
▽ F FREE " " " 269
S = 244.1 ft²
20.4% BALANCE
-.028
-.012
-.008
-.004
.004
.008
.012
12°
8°
4°
0°
-4°
-8°
-12°
-16°
-20°
-16°
-12°
-8°
-4°
0°
4°
8°
12°
16°
20°
ψ
C_y
C_y
ref


GALCIT FEB 22 1
PAGE 133
FIG 88
WBDNH2V2, α = 30°
ψ = 2.5°, R1 = 0°, RUN 326
RUN 327
RUN 328
RUN 329
RUN 330
RUN 331
RUN 332
R FREE 325
24% BALANCE
FINAL RUDDER SIZE OK
Cy
CH
RUDDER HINGE MOMENT AND EFFECTIVENESS AND RUDDER FREE STABILITY WITH H2V2


Svt = 24.1 ft²
20.4 % BALANCE
FINLAND RUDDER SIZES OK
Cy
r
.020 20°
.016 16°
.012 12°
.008 8°
.004 4°
0 0°
-.004 -4°
-.008 -8°
-.012 -12°
-16°
-24° -20° -16° -12° -8° -4° 0° 4° 8° 12° 16° 20° 24°
ψ
Cy
r

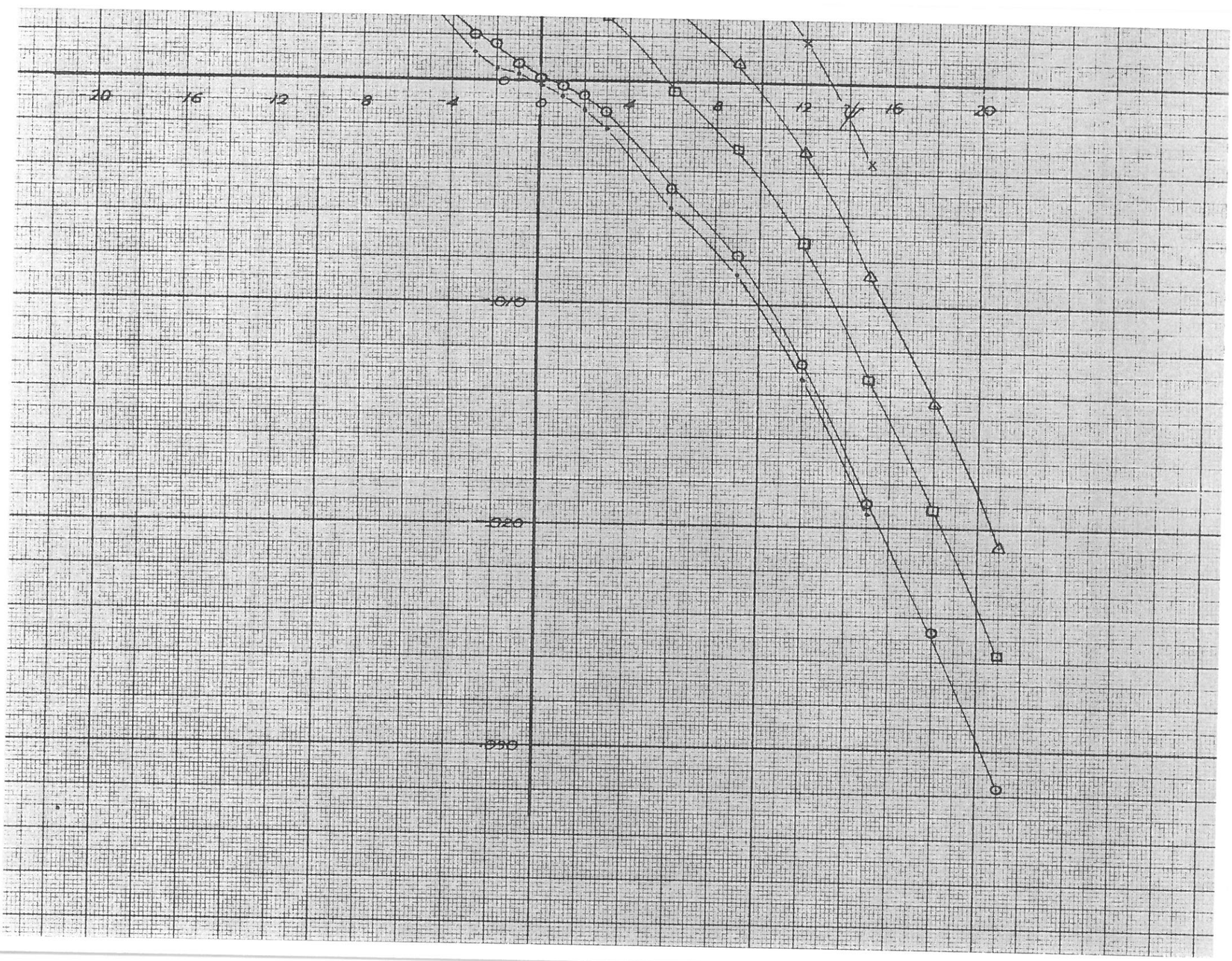


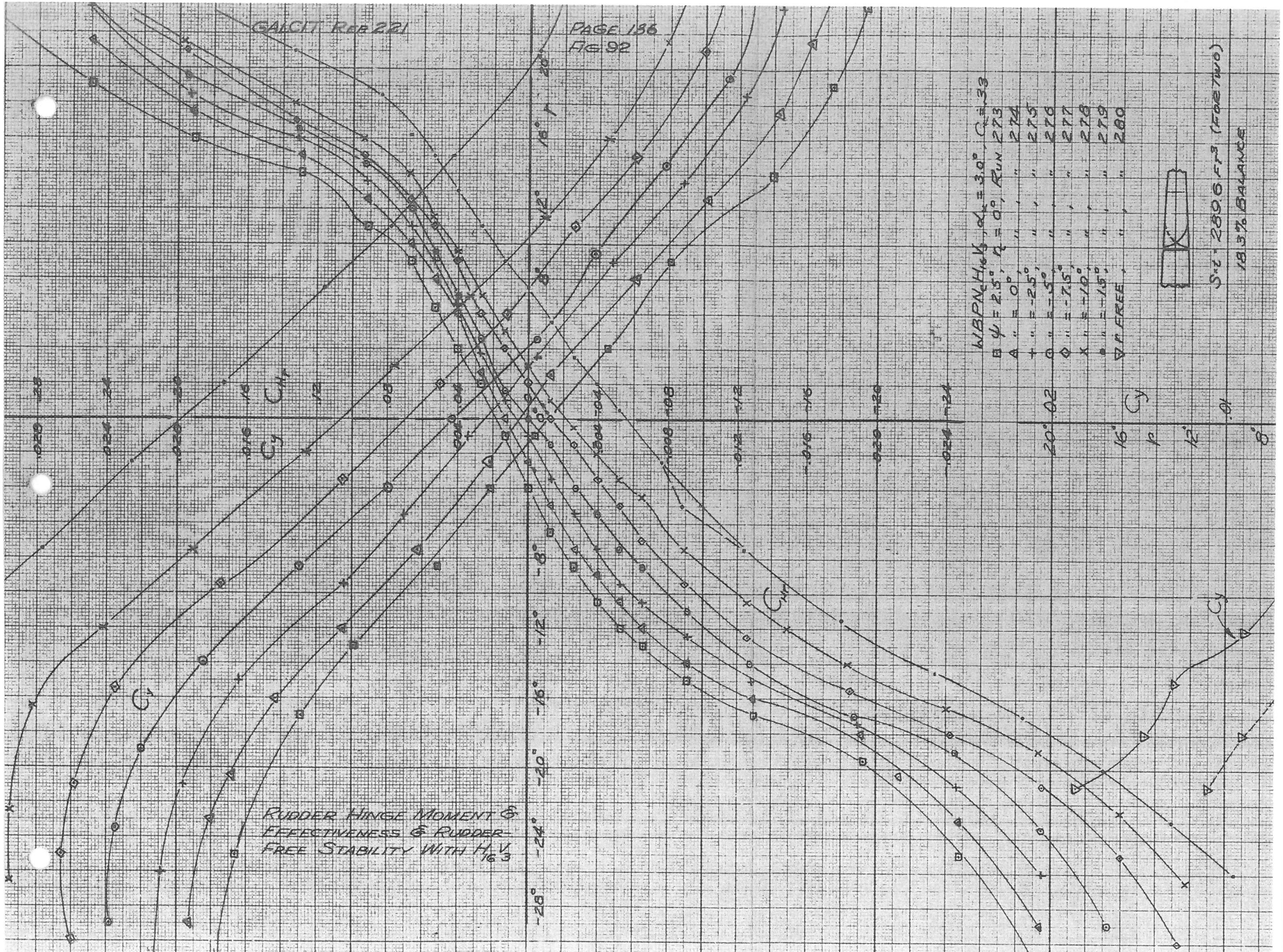
RUDDER HINGE MOMENT WITH H_3V_3



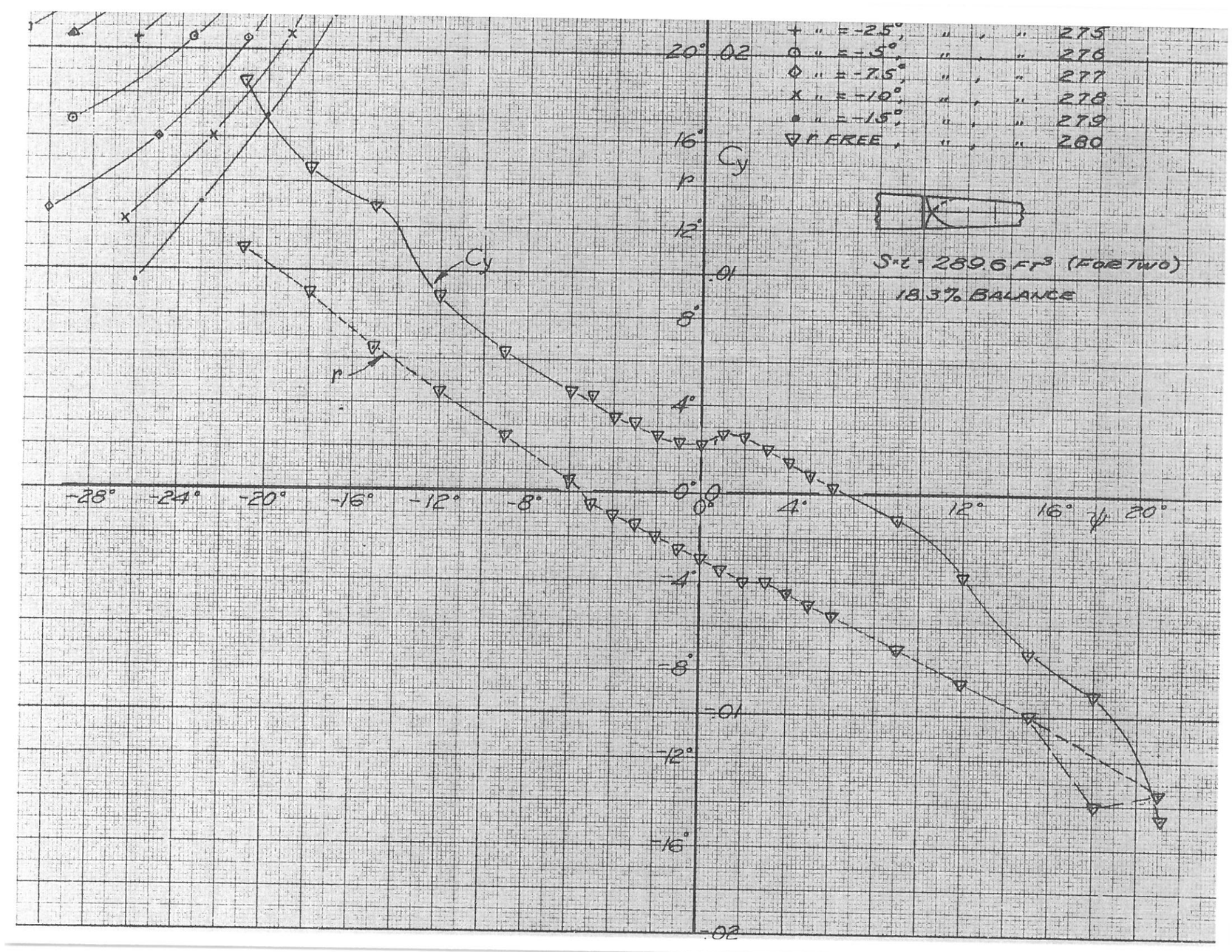
DIRECTIONAL STABILITY AND RUDDER EFFECTIVENESS WITH $H_3 V_3$

(20° = NOMINAL SETTING ONLY: RUDDER SLIPPED DURING THIS RUN. ANGLES AT END OF RUN WERE $\delta_r = -17.5°$; $\gamma = -17.4°$)


-20
-16
-12
-8
-4
0
4
8
12
16
20
-.010
-.020
-.030

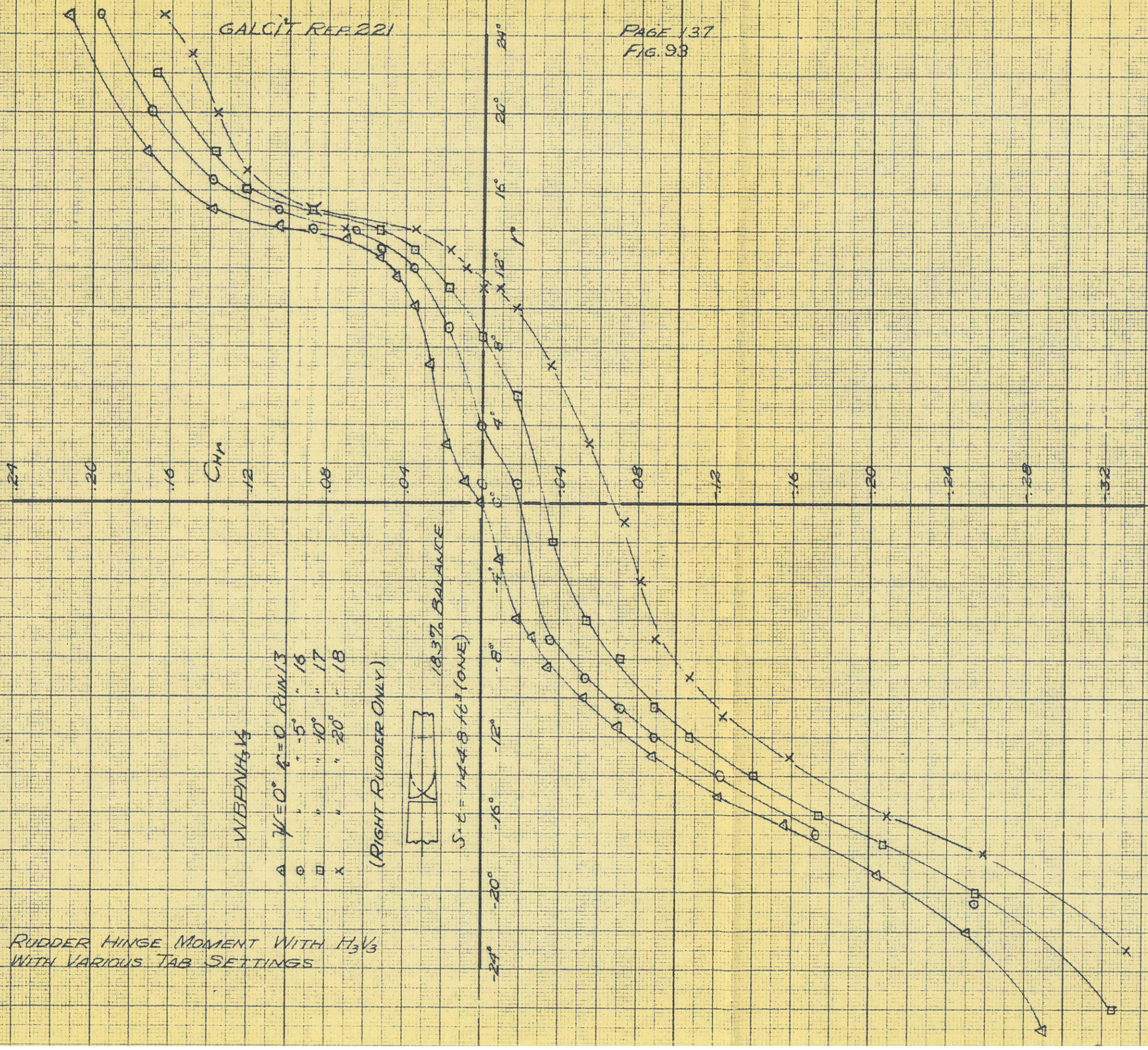


RUDDER HINGE MOMENT & EFFECTIVENESS & RUDDER-FREE STABILITY WITH $H_{16}V_3$

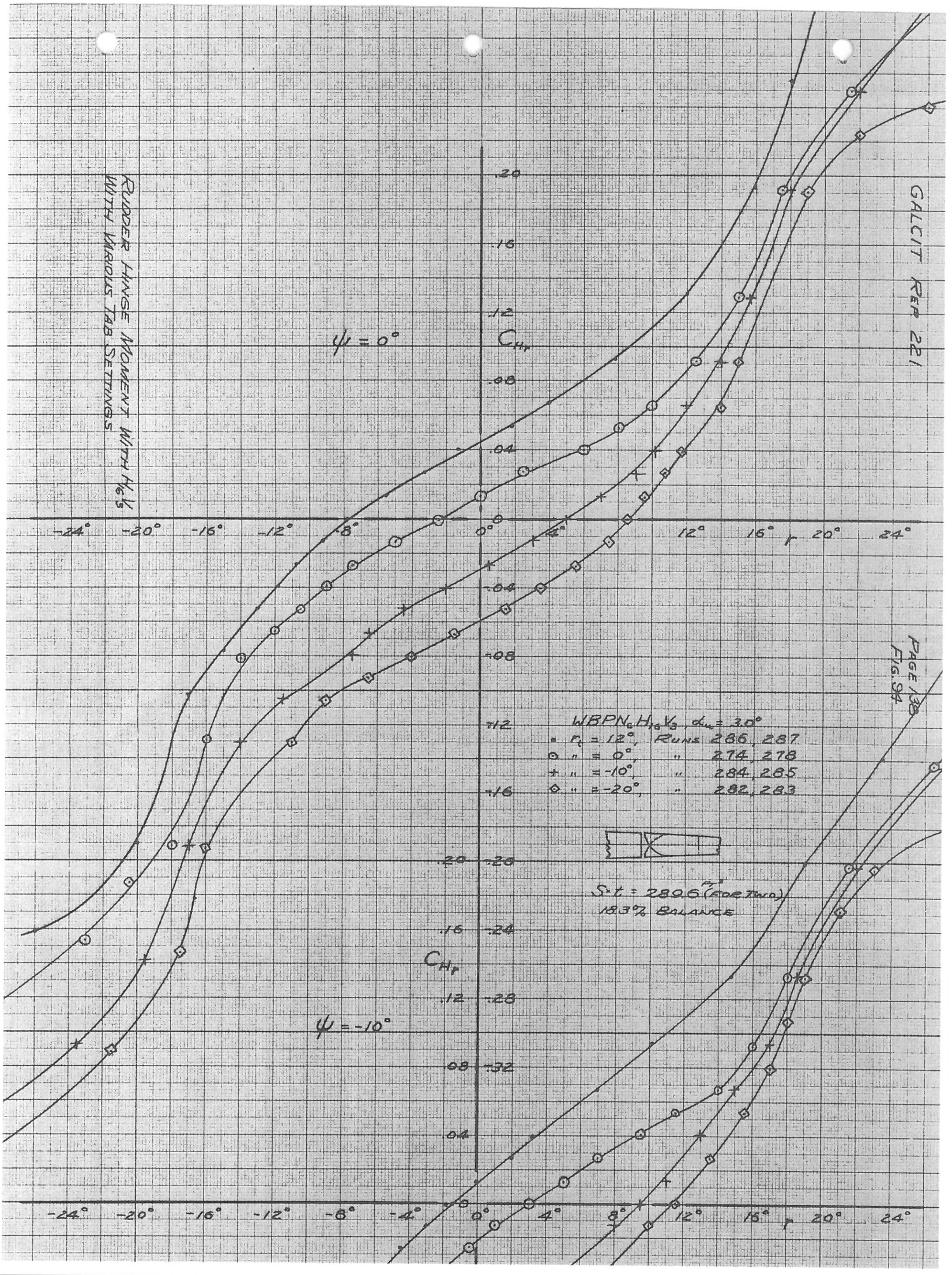

+ " ε=-2.5°, " " " 275
⊙ " ε=-5°, " " " 276
◇ " ε=-7.5°, " " " 277
X " ε=-10°, " " " 278
● " ε=-15°, " " " 279
▽ FREE, " " " 280
Cy
p
S·t = 289.6 Ft³ (FOR TWO)
18.3% BALANCE
.02
.01
-.01
-.02
20°
16°
12°
8°
4°
0°
-4°
-8°
-12°
-16°
-28°
-24°
-20°
-16°
-12°
-8°
0°
4°
12°
16°
20°
ψ

GALCIT REF. 221

PAGE 137
FIG. 93



RUDDER HINGE MOMENT WITH H_3V_3 WITH VARIOUS TAB SETTINGS


RUDDER HINGE MOMENT WITH $H_{6/5}$ WITH VARIOUS TAB SETTINGS
$\psi = 0°$
$\psi = -10°$
C_{H_r}
α
WBPN$_6$H$_{1/6}$V$_3$, $\alpha_w = 3.0°$
$\delta_r = 12°$, RUNS 286, 287
$\delta_r = 0°$, " 274, 278
$\delta_r = -10°$, " 284, 285
$\delta_r = -20°$, " 282, 283
$S_t = 280.6$ sq in (ONE TAIL)
18.3% BALANCE

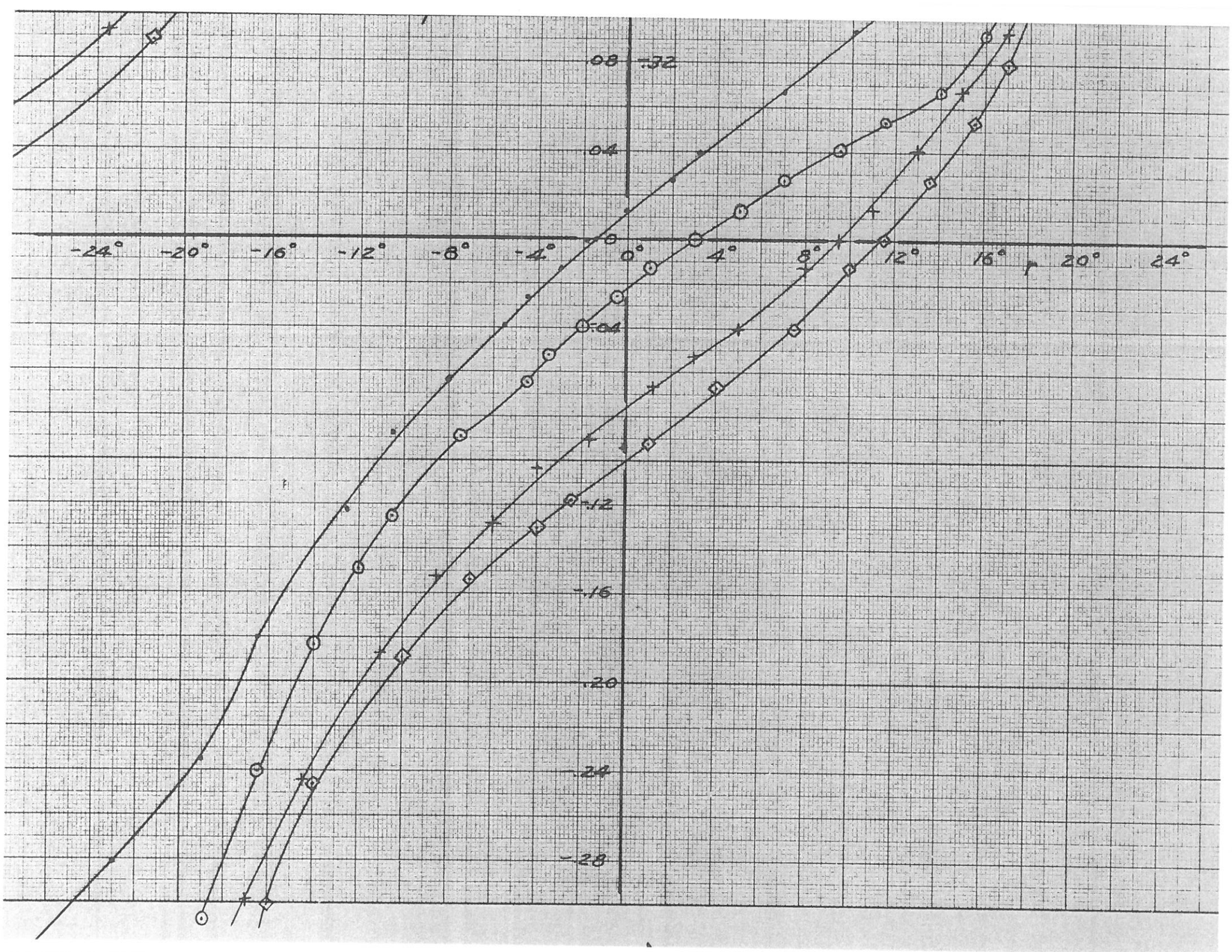
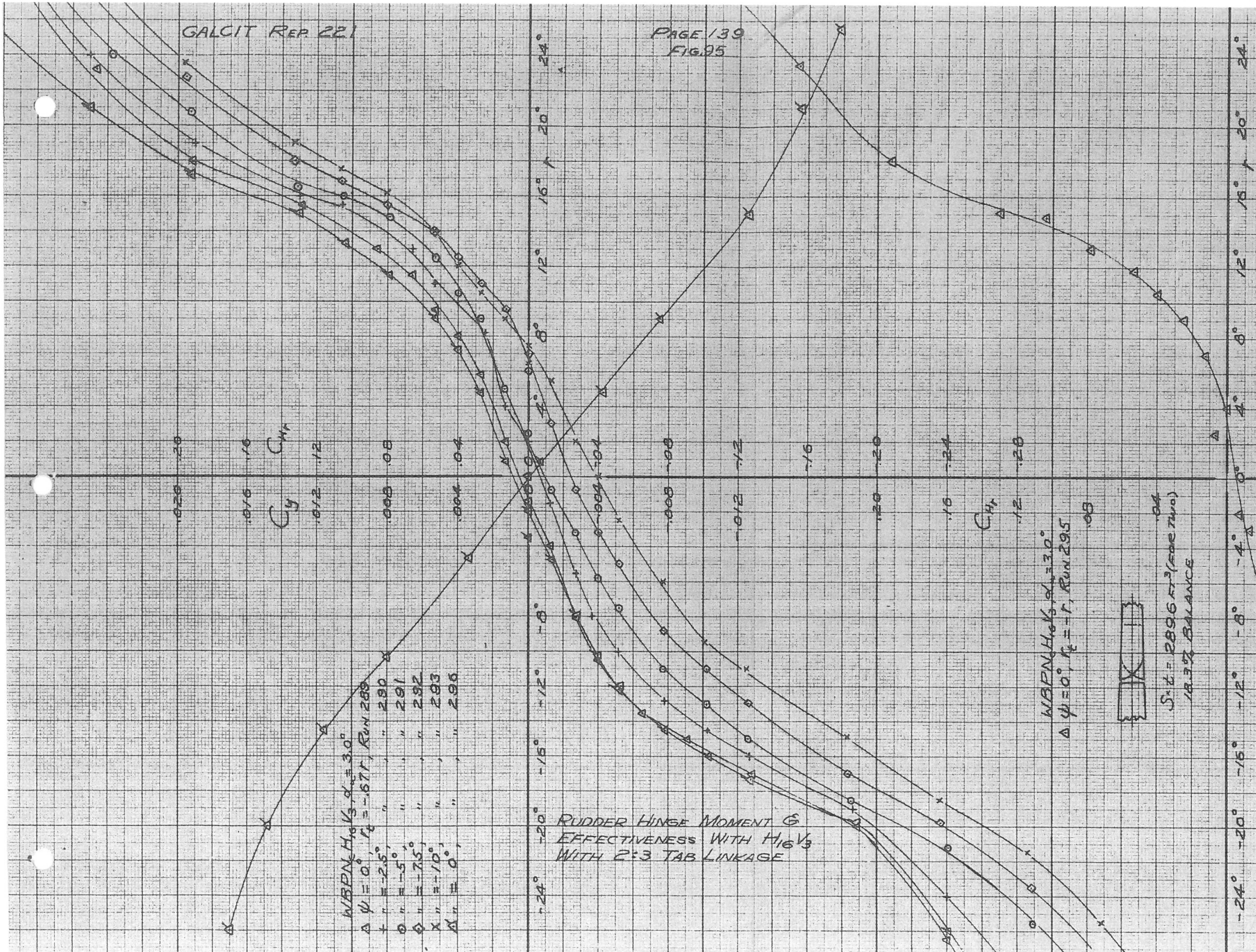
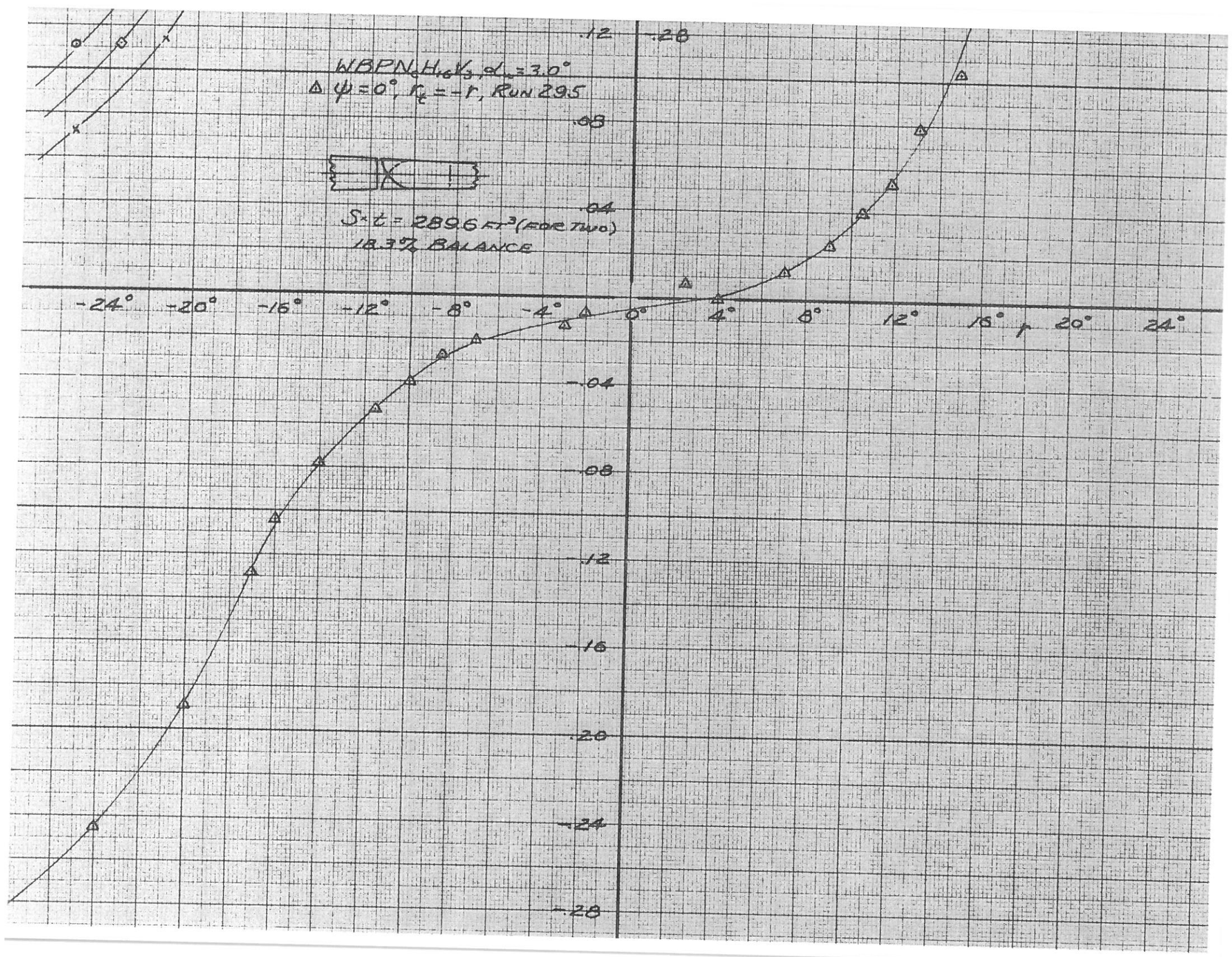
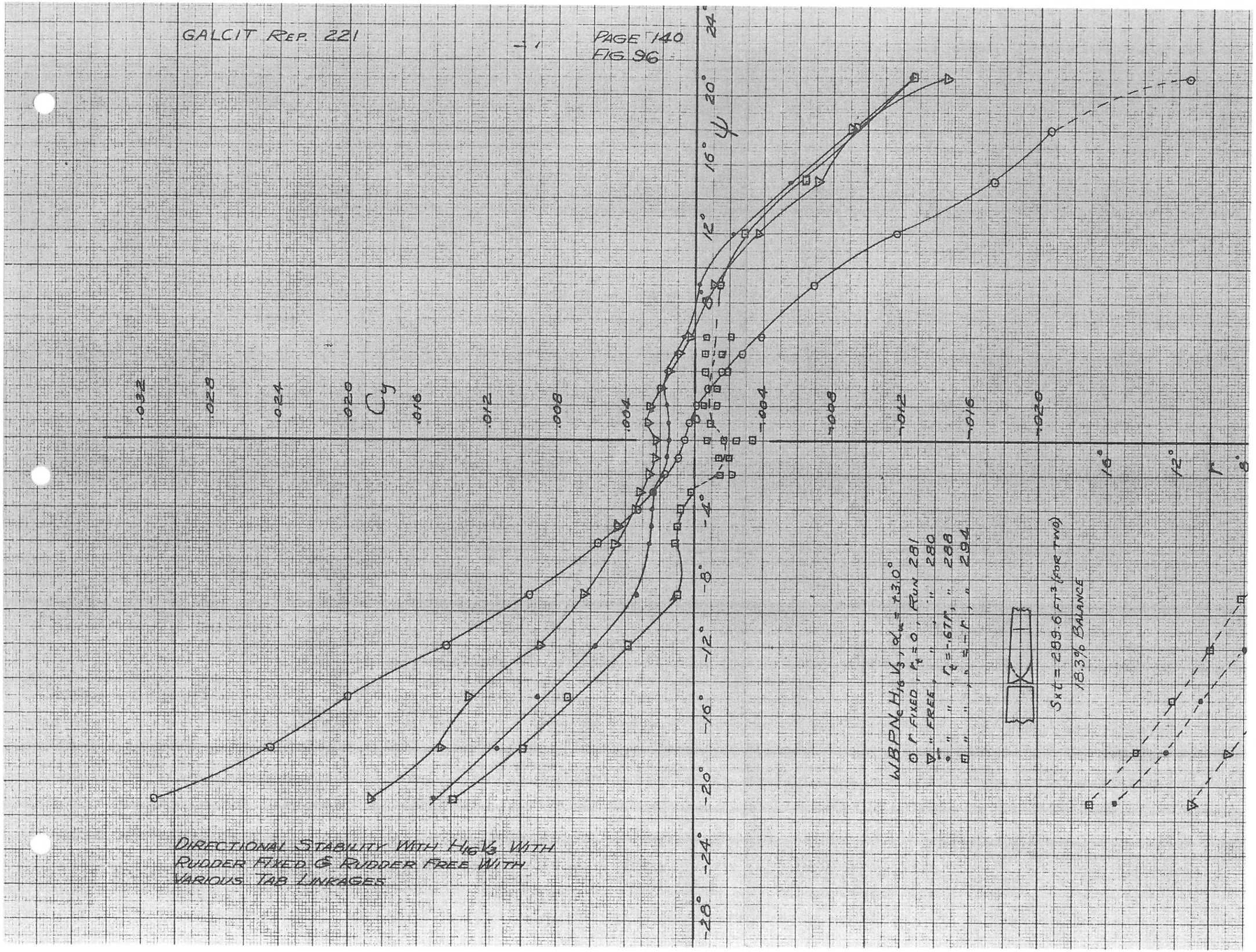

.08
.04
-.04
-.12
-.16
-.20
-.24
-.28
-24°
-20°
-16°
-12°
-8°
-4°
0°
4°
8°
12°
16°
20°
24°

FIG. 95

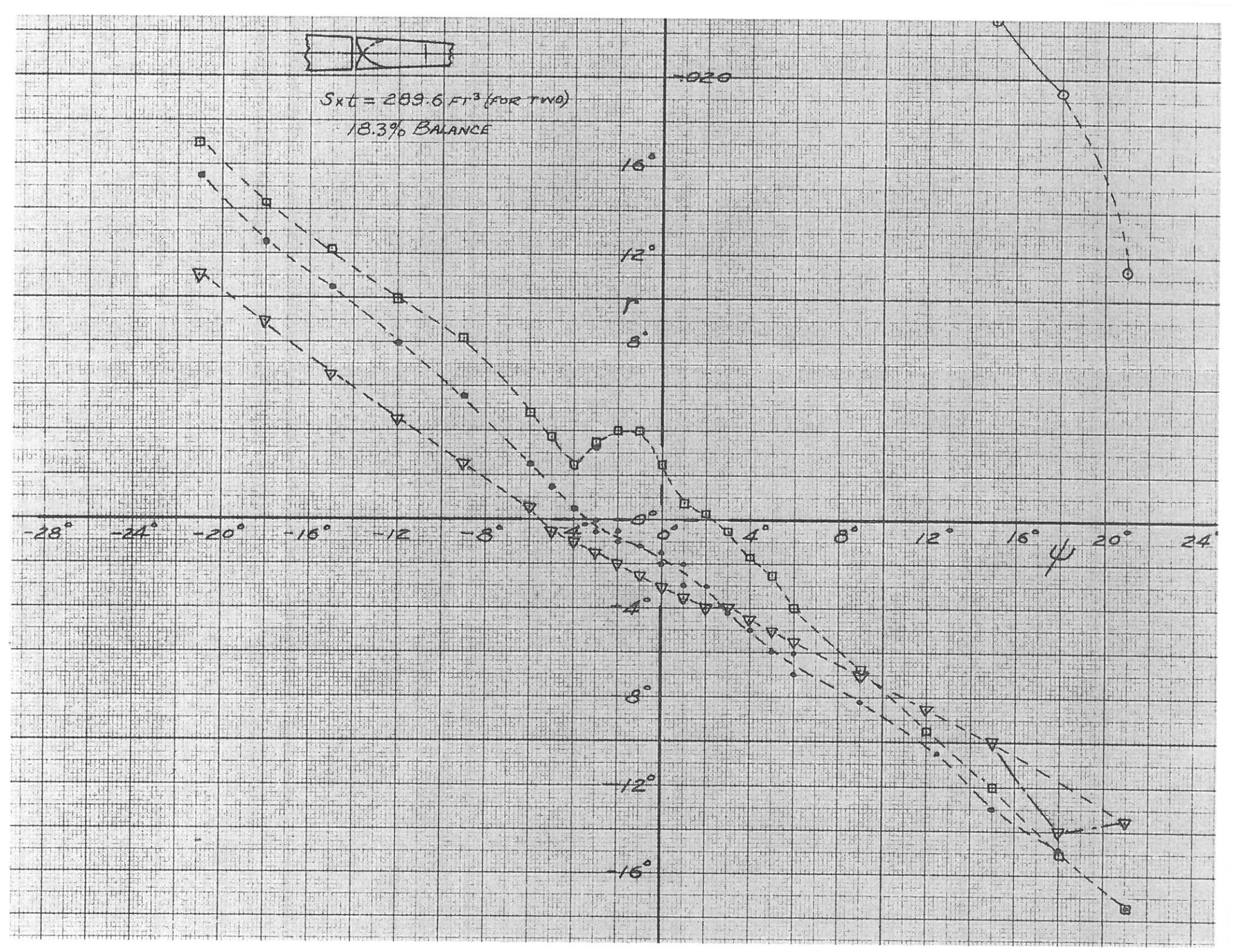


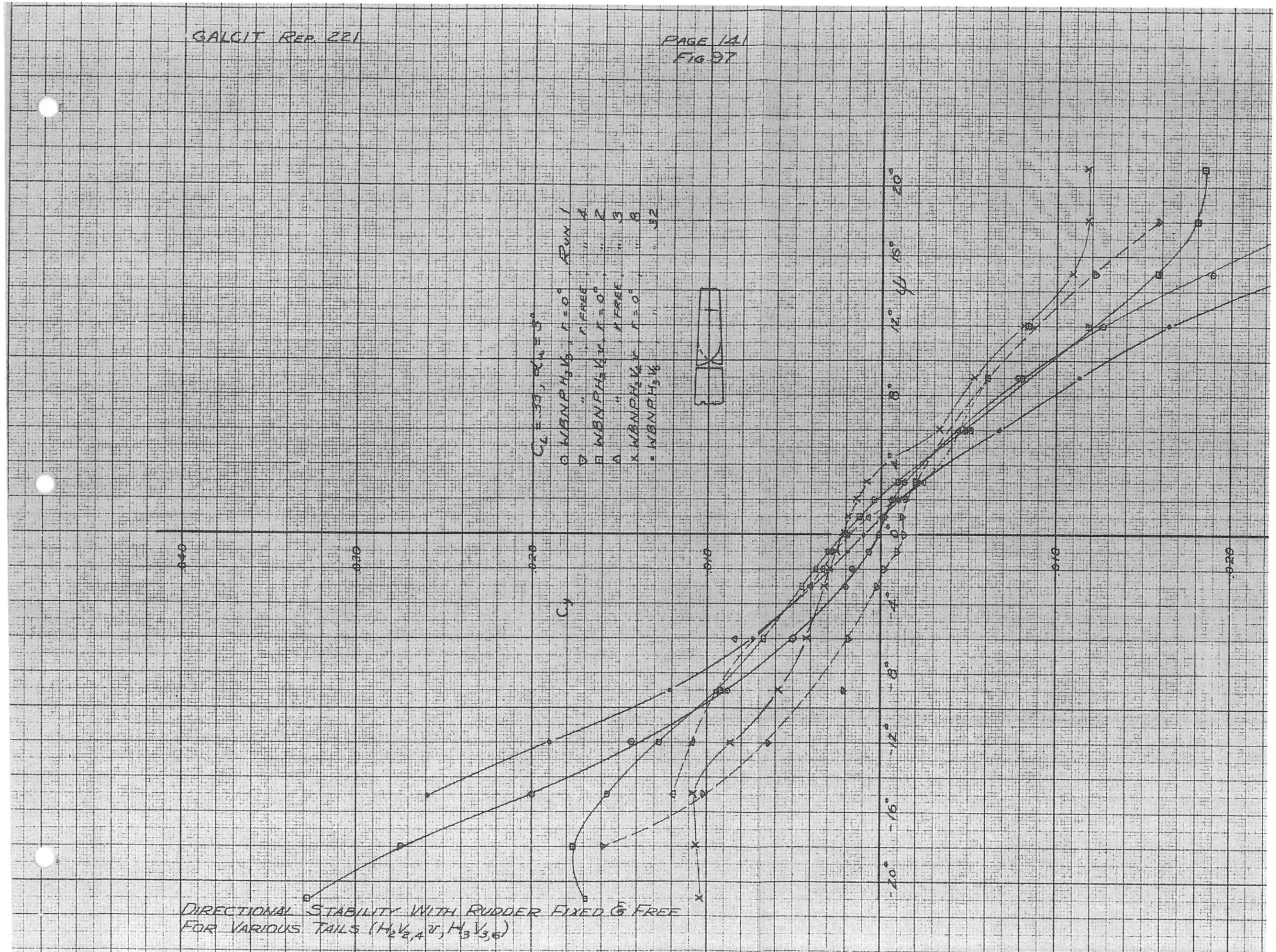
RUDDER HINGE MOMENT C_H EFFECTIVENESS WITH $H_{16}V_3$ WITH 2:3 TAB LINKAGE


WBPN$_6$H$_{16}$V$_3$, α_t = 3.0°
△ ψ = 0°, i_t = -1, RUN 29.5
S·ℓ = 289.6 FT² (FOR TWO)
18.3% BALANCE
.12
.08
.04
-.04
-.08
-.12
-.16
-.20
-.24
-.28
-24°
-20°
-16°
-12°
-8°
-4°
0°
4°
8°
12°
16°
20°
24°
α

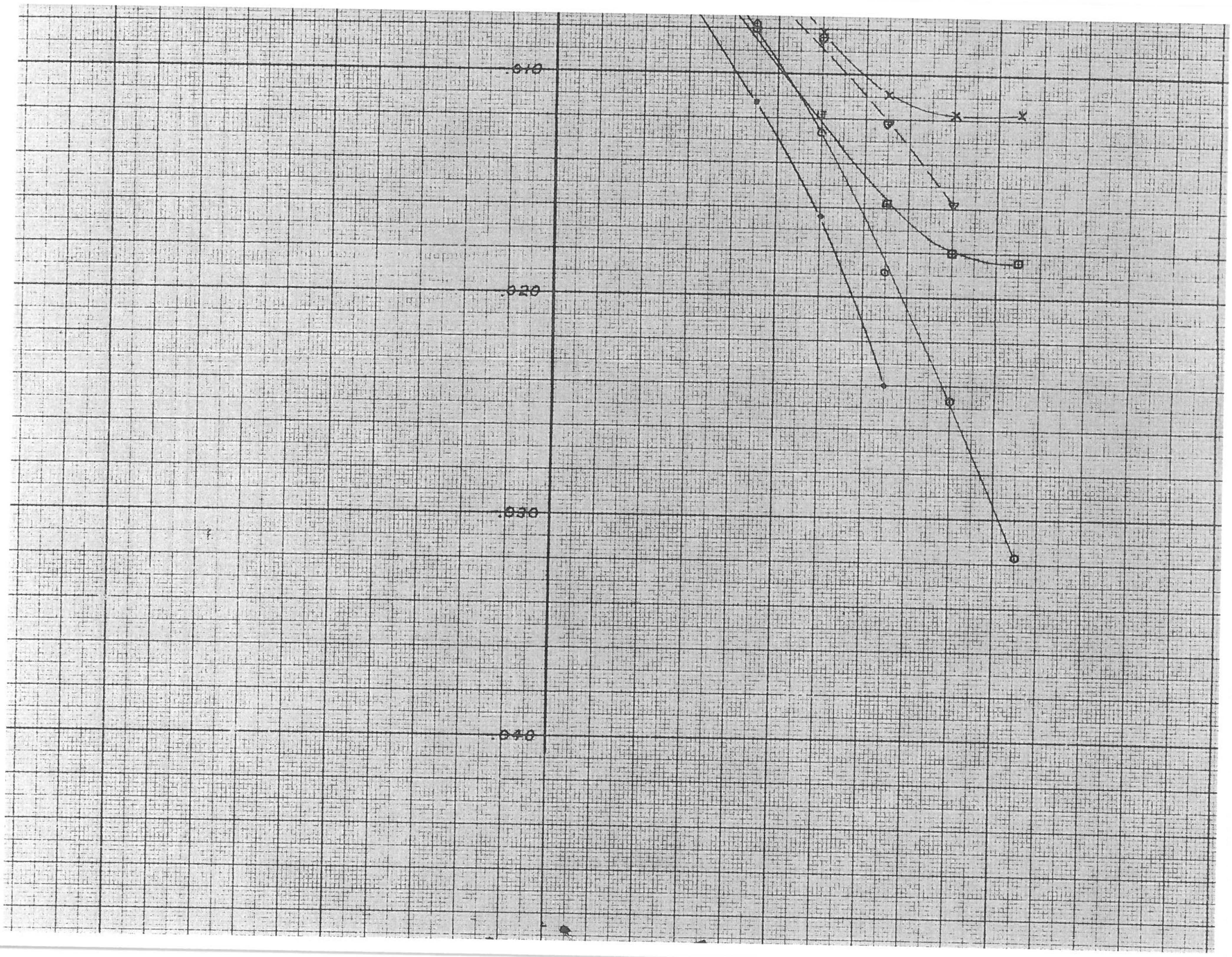


DIRECTIONAL STABILITY WITH $H_{16}V_3$ WITH RUDDER FIXED & RUDDER FREE WITH VARIOUS TAB LINKAGES


S x t = 289.6 FT³ (FOR TWO)
18.3% BALANCE
-920
16°
12°
8°
4°
0°
-4°
-8°
-12°
-16°
-28°
-24°
-20°
-16°
-12
-8°
4°
8°
12°
16°
20°
24°
ψ



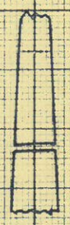
DIRECTIONAL STABILITY WITH RUDDER FIXED & FREE FOR VARIOUS TAILS ($H_2V_{2.4}$ Y, $H_3V_{3.6}$)

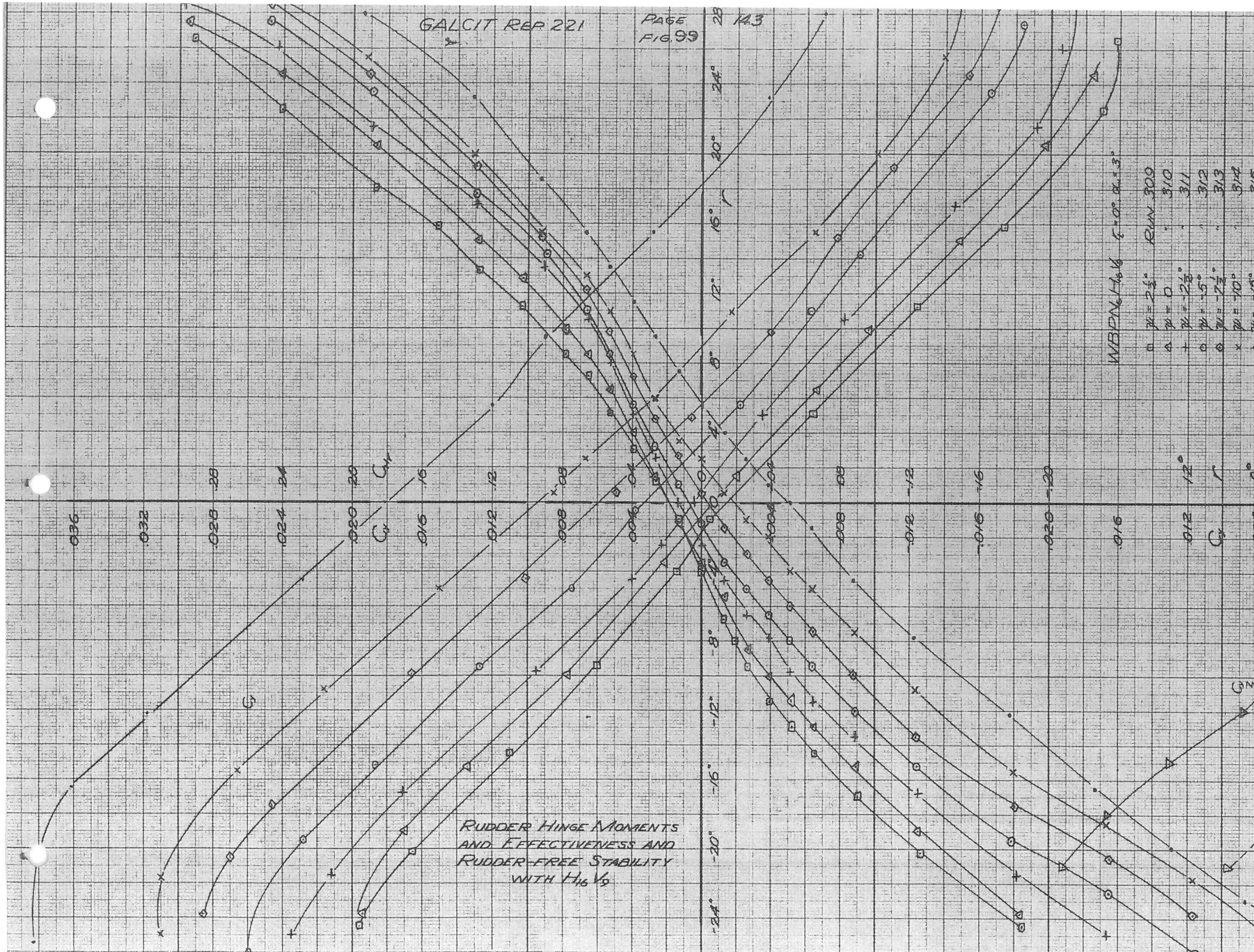

.010
.020
.030
.040

RUDDER HINGE MOMENT WITH H_3V_5

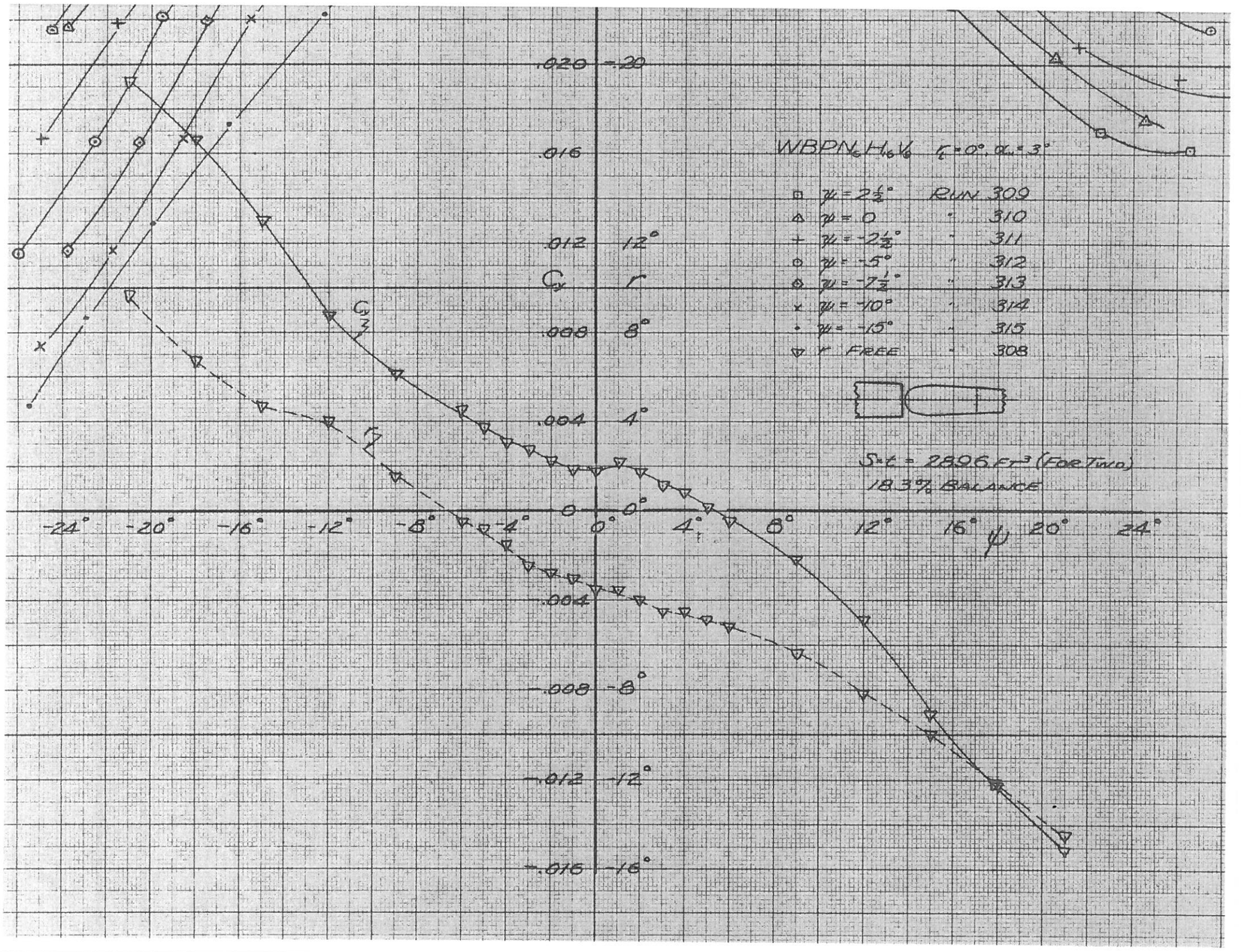
$WBNPH_3V_5$, $C_f = .33$, $\alpha_w = 3°$
△ $\psi = 0°$, $\eta = 0°$, RUN 23
○ " $-5°$, " 24
× " $\pm 10°$, " 25
(RIGHT RUDDER ONLY)

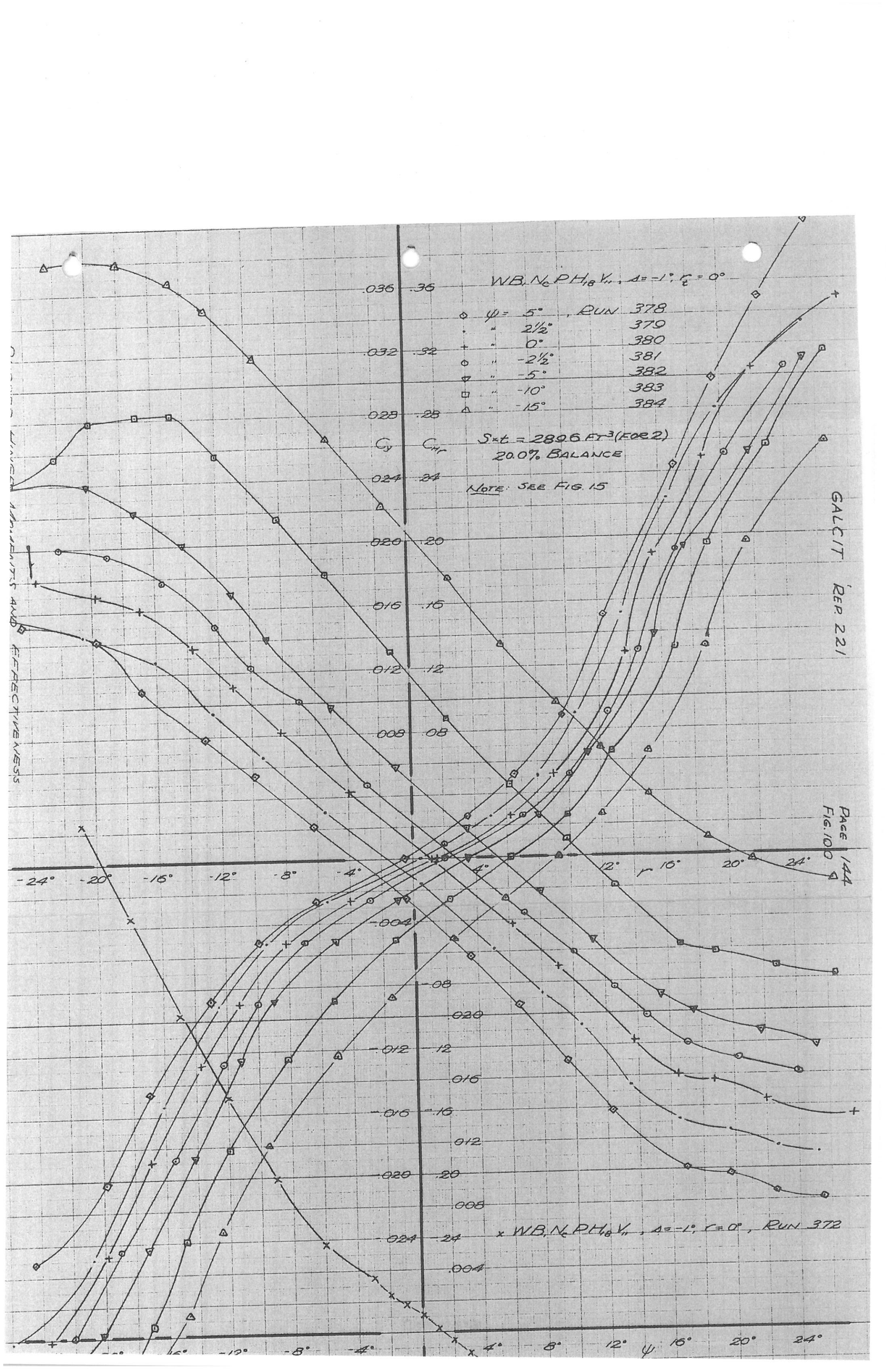
$S_R = 1448$ FT^2 (FOR ONE)
18.3% BALANCE





Rudder Hinge Moments and Effectiveness and Rudder-free Stability with $H_{16}V_9$


WBPN6 H6 V6 i_t = 0°, α_w = 3°
□ γ_w = 2½° RUN 309
△ γ_w = 0 " 310
+ γ_w = -2½° " 311
○ γ_w = -5° " 312
◇ γ_w = -7½° " 313
× γ_w = -10° " 314
• γ_w = -15° " 315
▽ γ_w FREE " 308
S_t = 2896 Ft² (Fore Two)
18.3% Balance
C_Y
C_n
C_l
ψ
.020
.016
.012
.008
.004
-.004
-.008
-.012
-.016
-.20
12°
8°
4°
0°
-8°
-12°
-16°
-24°
-20°
-16°
-12°
-8°
-4°
0°
4°
8°
12°
16°
20°
24°


W.B. N_c P H_18 V_11, Δ = -1°; Γ_t = 0°
ψ = 5°, RUN 378
2½° 379
0° 380
-2½° 381
-5° 382
-10° 383
-15° 384
S×t = 2896 FT³ (FOR 2)
20.0% BALANCE
NOTE: SEE FIG. 15
C_y
C_H,r
ψ
Γ
× W.B. N_c P H_18 V_11, Δ = -1°, Γ = 0°, RUN 372
GALCIT REP 221
PAGE 144
FIG. 100
EFFECTIVENESS AND MOMENTS UNDER

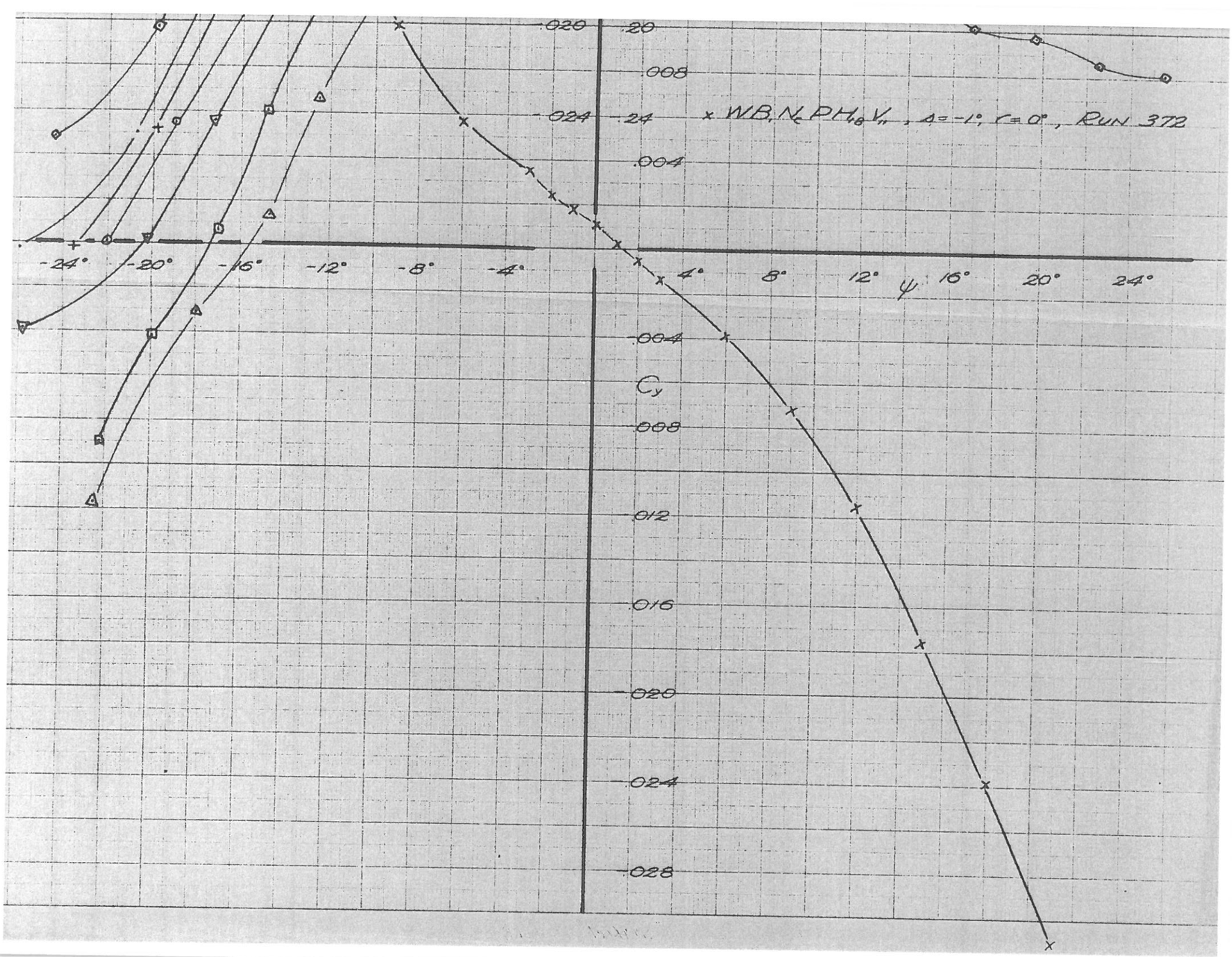
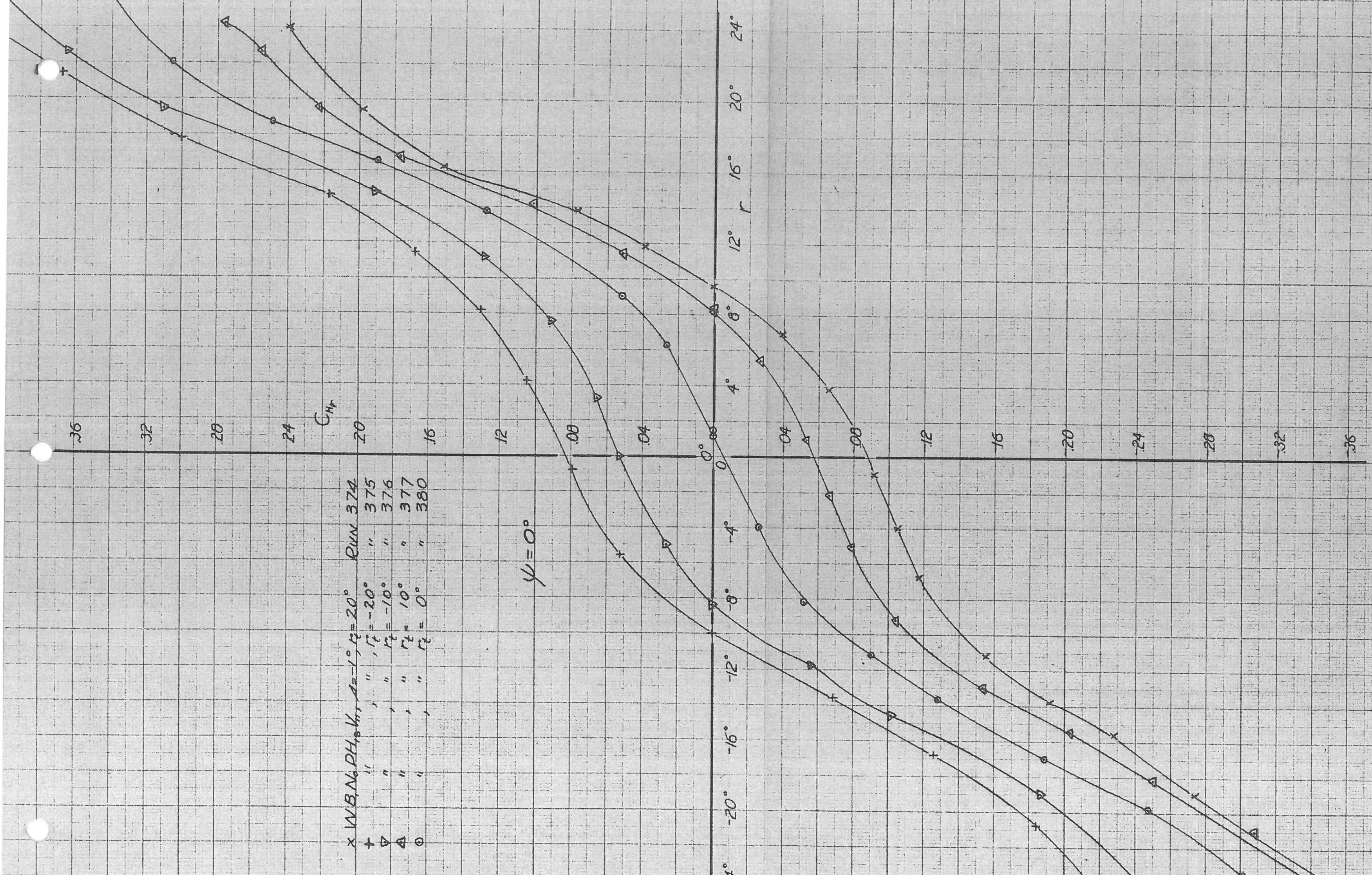
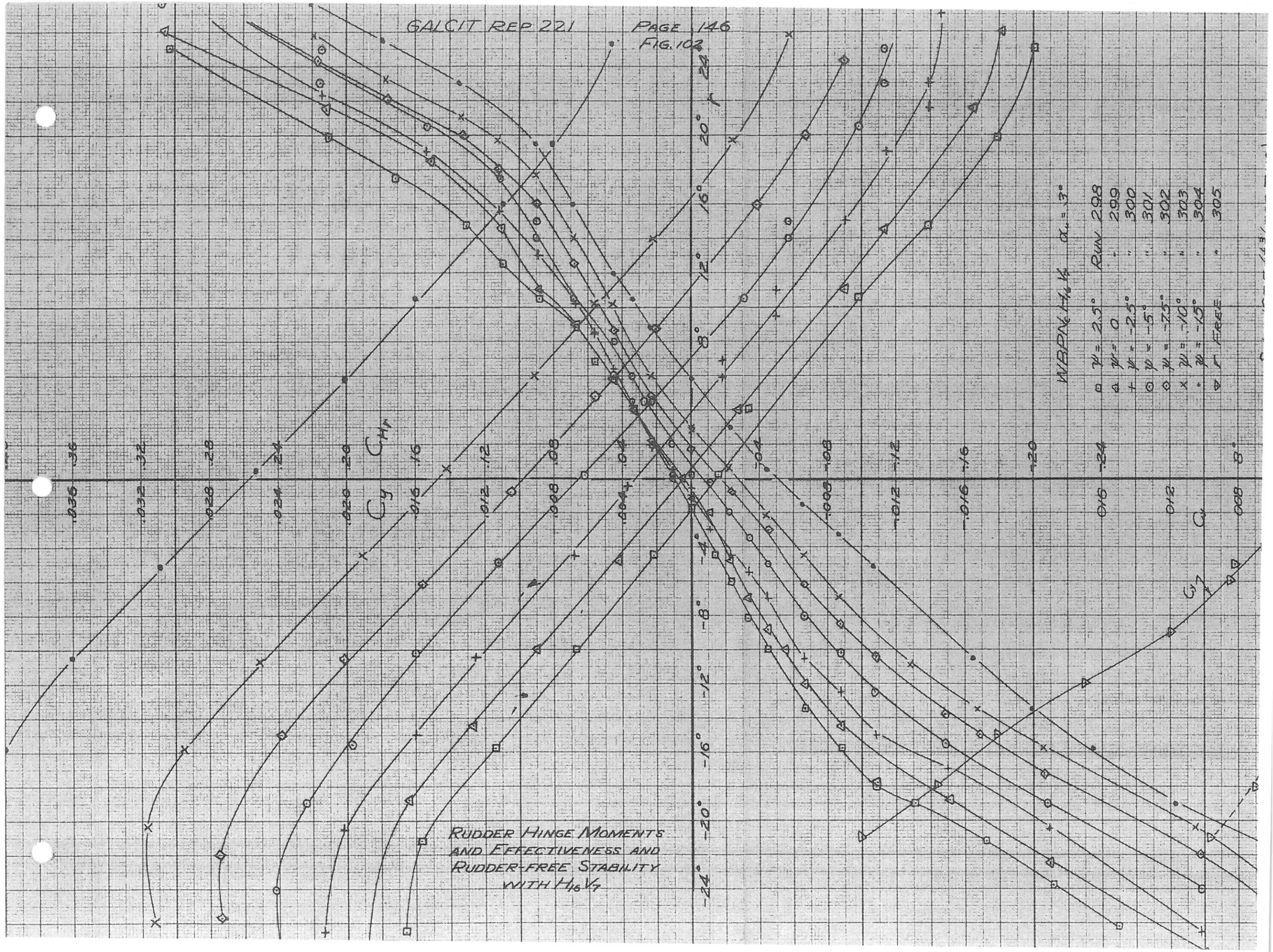

.020
.008
-.024
-.24
.004
x WB, Nc PH16 V11 , Δ=-1°, r=0°, RUN 372
-24°
-20°
-16°
-12°
-8°
-4°
4°
8°
12°
ψ
16°
20°
24°
-.004
Cy
-.008
-.012
-.016
-.020
-.024
-.028

FIG. 101



RUDDER HINGE MOMENTS AND TAB EFFECTIVENESS WITH $H_{18}V_{11}$


WING 44-14 α = 3°
□ ψ = 2.5° RUN 298
△ ψ = 0 " 299
+ ψ = -2.5° " 300
○ ψ = -5° " 301
◇ ψ = -7.5° " 302
× ψ = -10° " 303
· ψ = -15° " 304
▽ FREE " 305
C_{HR}
C_y
C_l
RUDDER HINGE MOMENTS AND EFFECTIVENESS AND RUDDER-FREE STABILITY WITH $H_{16}V_7$

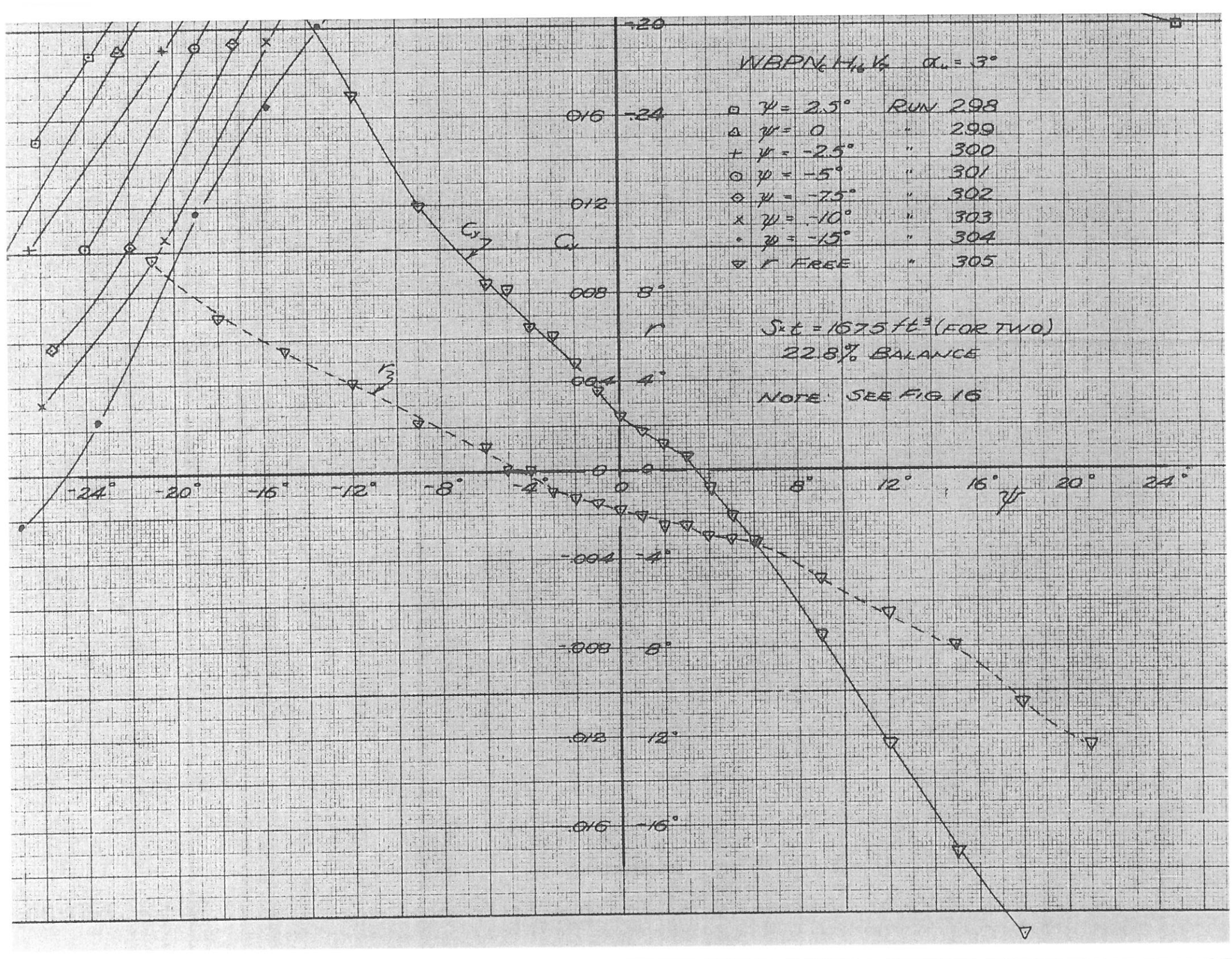
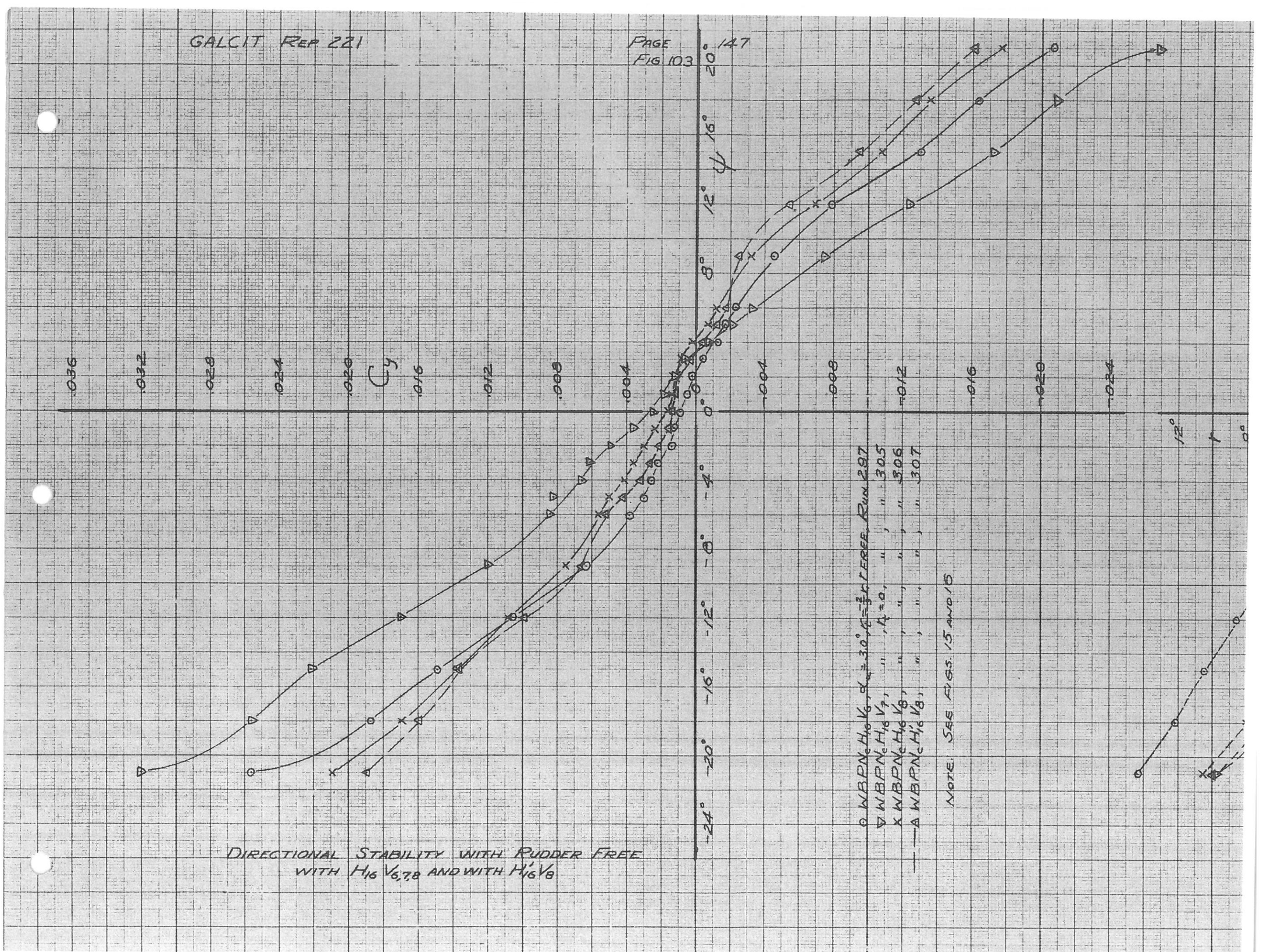
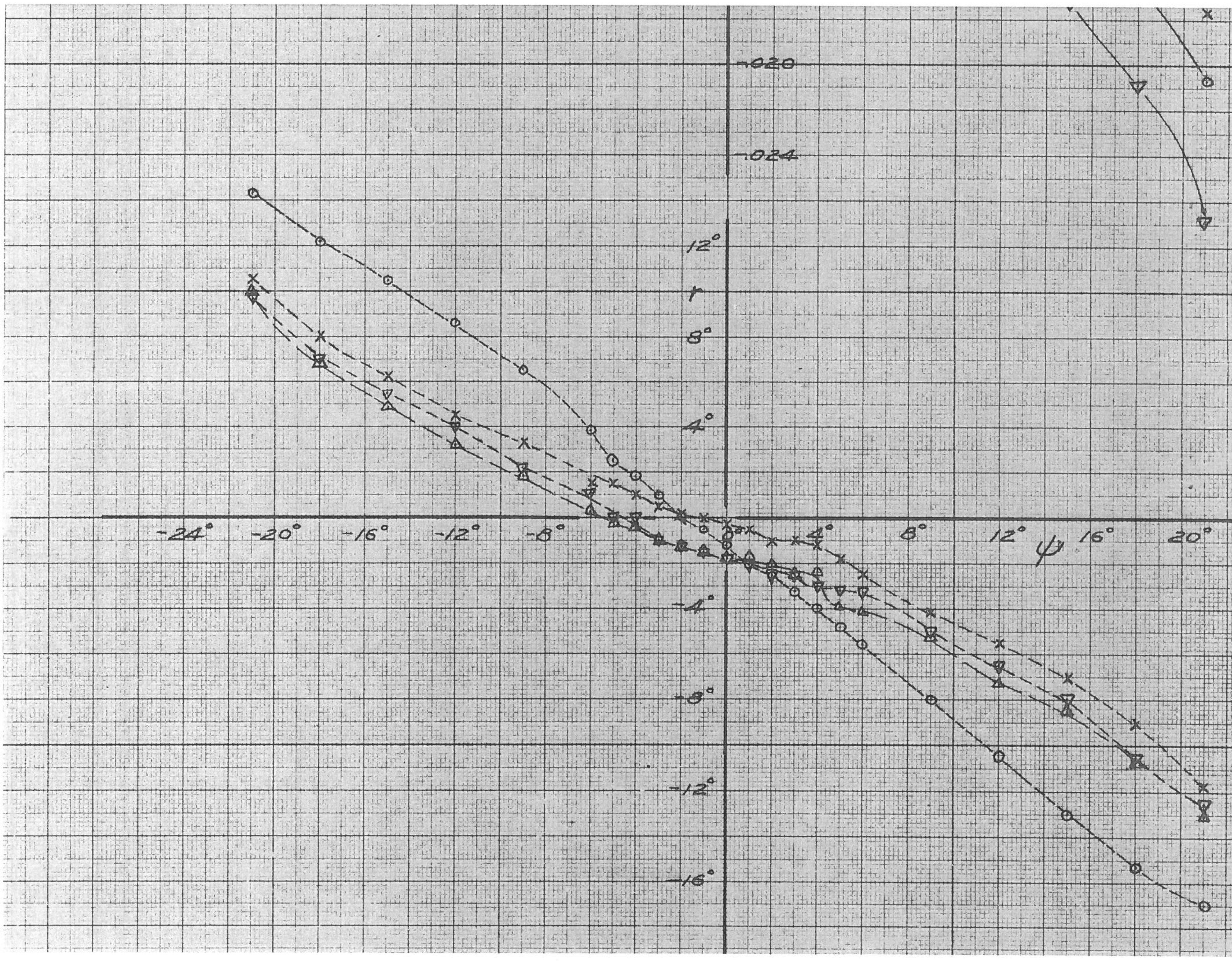

WBPN6 H1/6 V1/4 α = 3°
□ ψ = 2.5° RUN 298
△ ψ = 0 " 299
+ ψ = -2.5° " 300
○ ψ = -5° " 301
◇ ψ = -7.5° " 302
× ψ = -10° " 303
• ψ = -15° " 304
▽ F FREE " 305
S·t = 1675 ft³ (FOR TWO)
22.8% BALANCE
NOTE SEE FIG 16
Cy
Cl
F
ψ
-.20
-.16
-.12
-.08
-.04
.04
.08
.12
.16
-24°
-20°
-16°
-12°
-8°
-4°
0
4°
8°
12°
16°
20°
24°

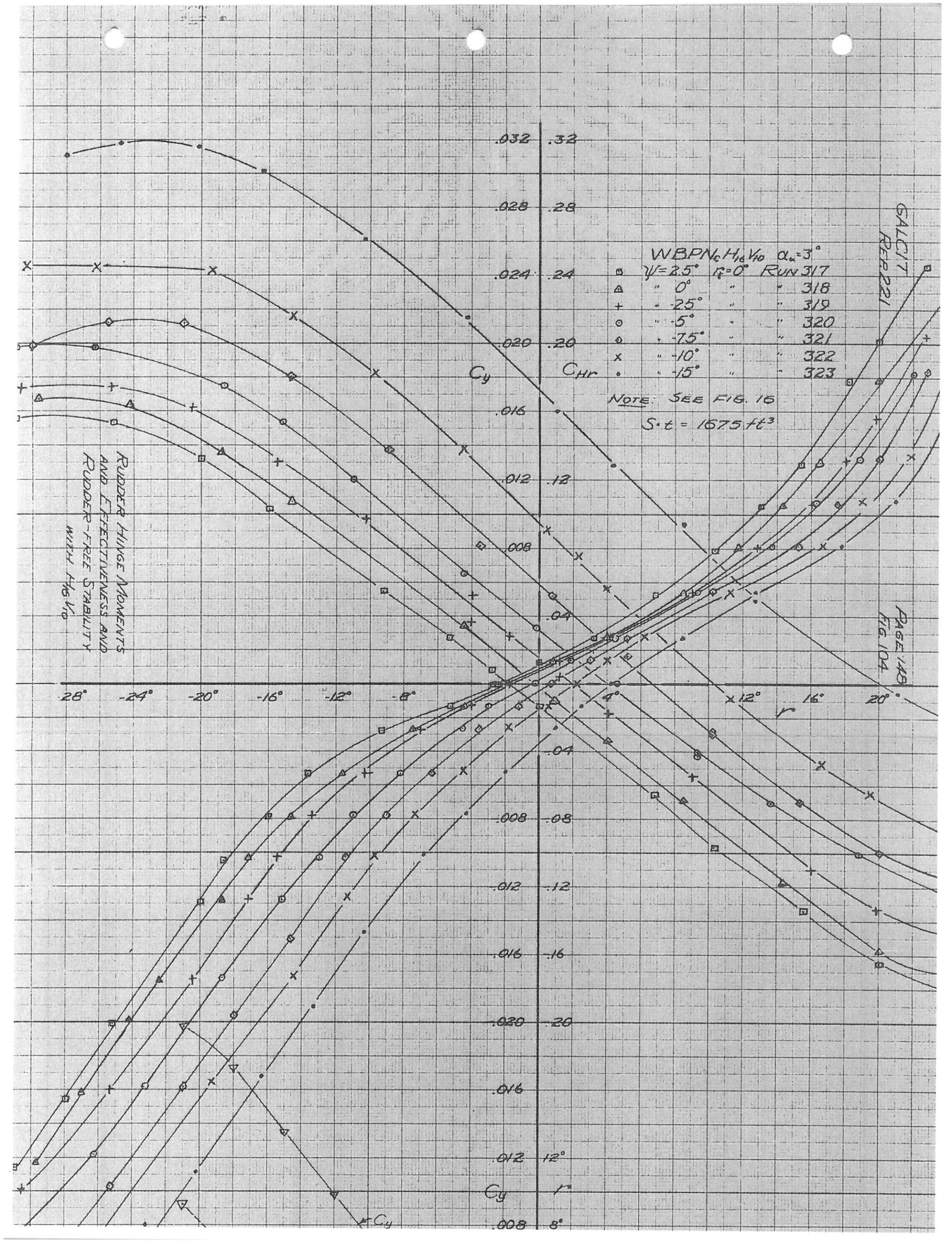
FIG 103

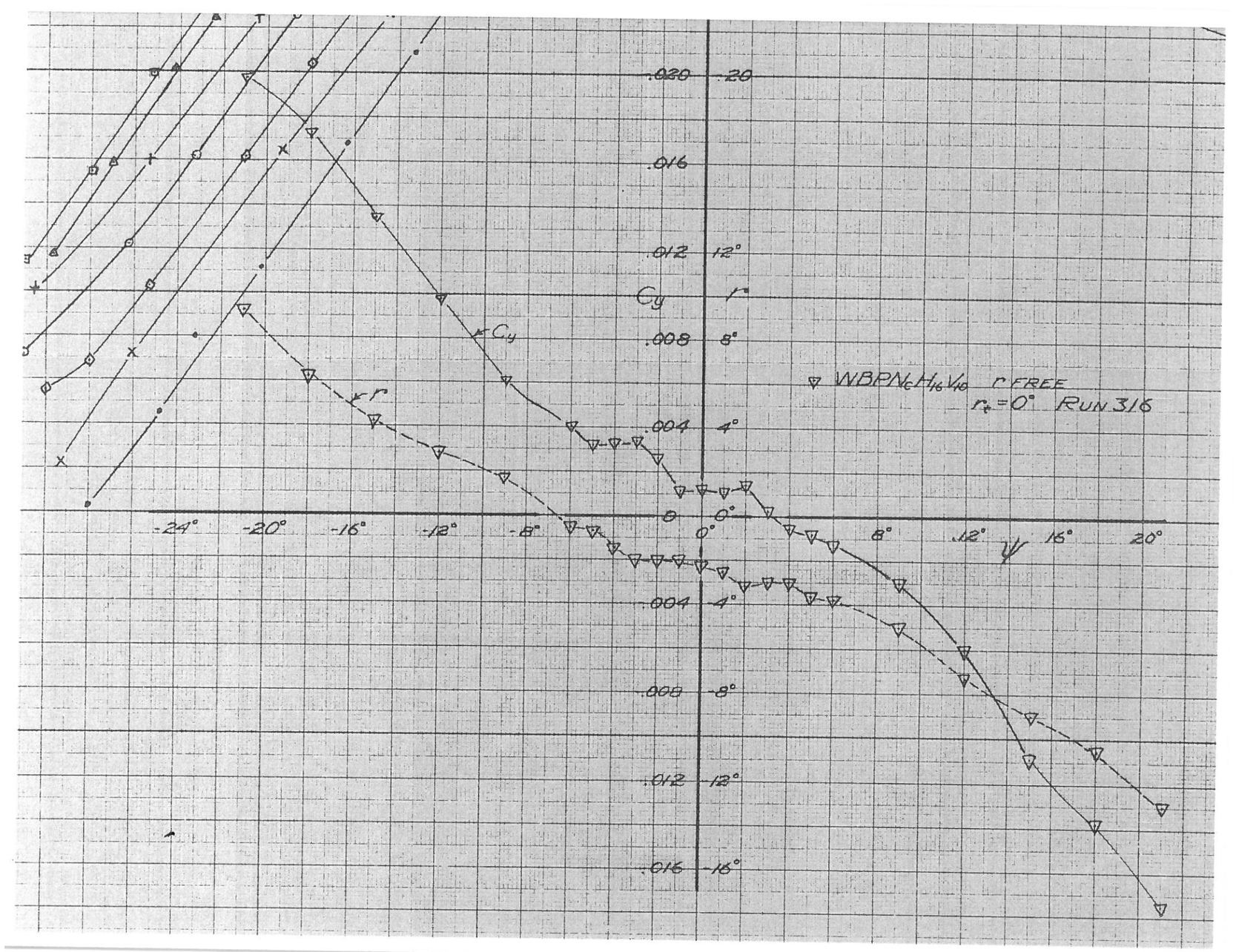


DIRECTIONAL STABILITY WITH RUDDER FREE
WITH $H_{1/6}V_{6,7,8}$ AND WITH $H'_{1/6}V_8$



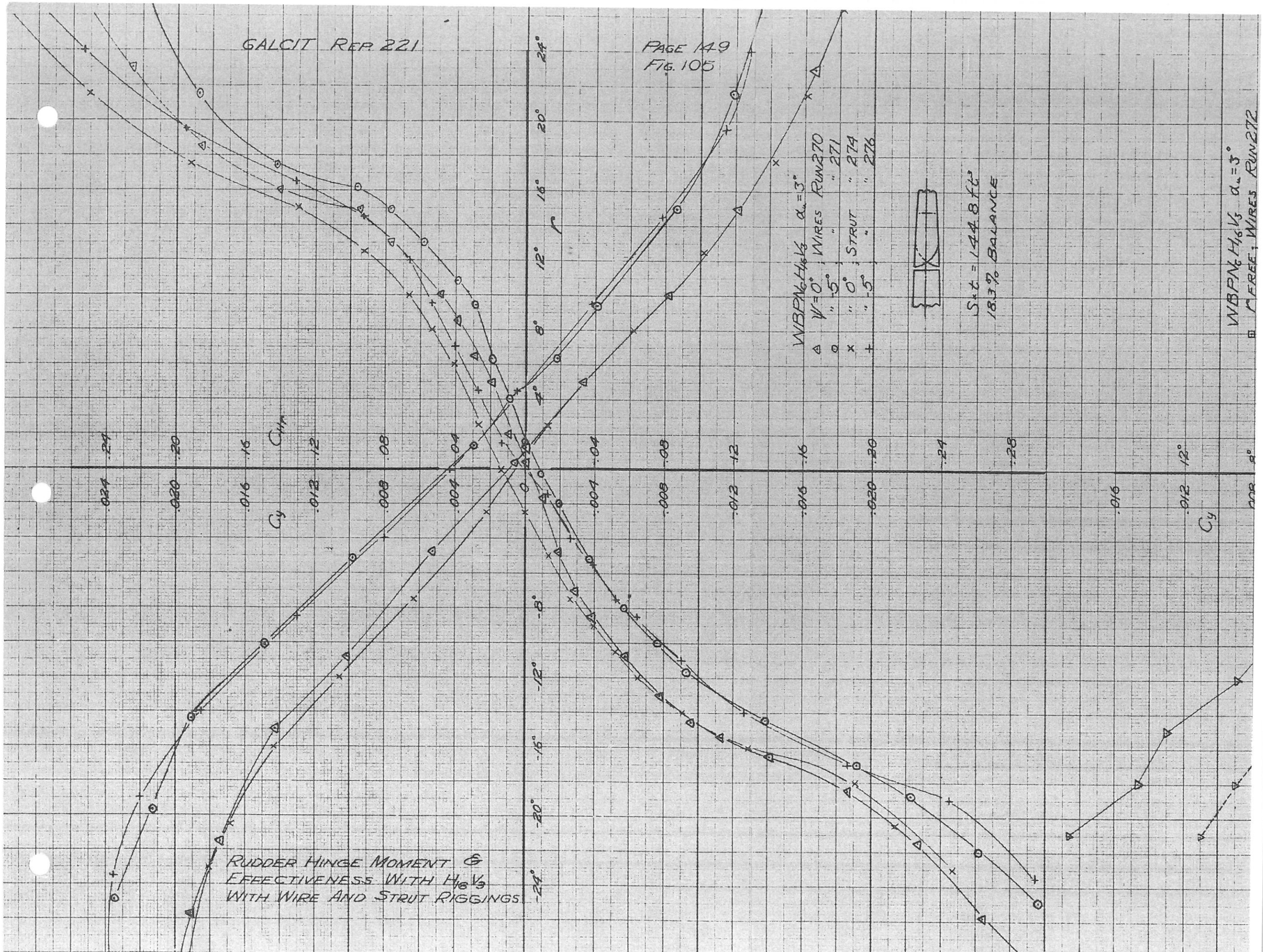
-.020
-.024
12°
r
8°
4°
-4°
-8°
-12°
-16°
-24°
-20°
-16°
-12°
-8°
4°
8°
12°
ψ
16°
20°

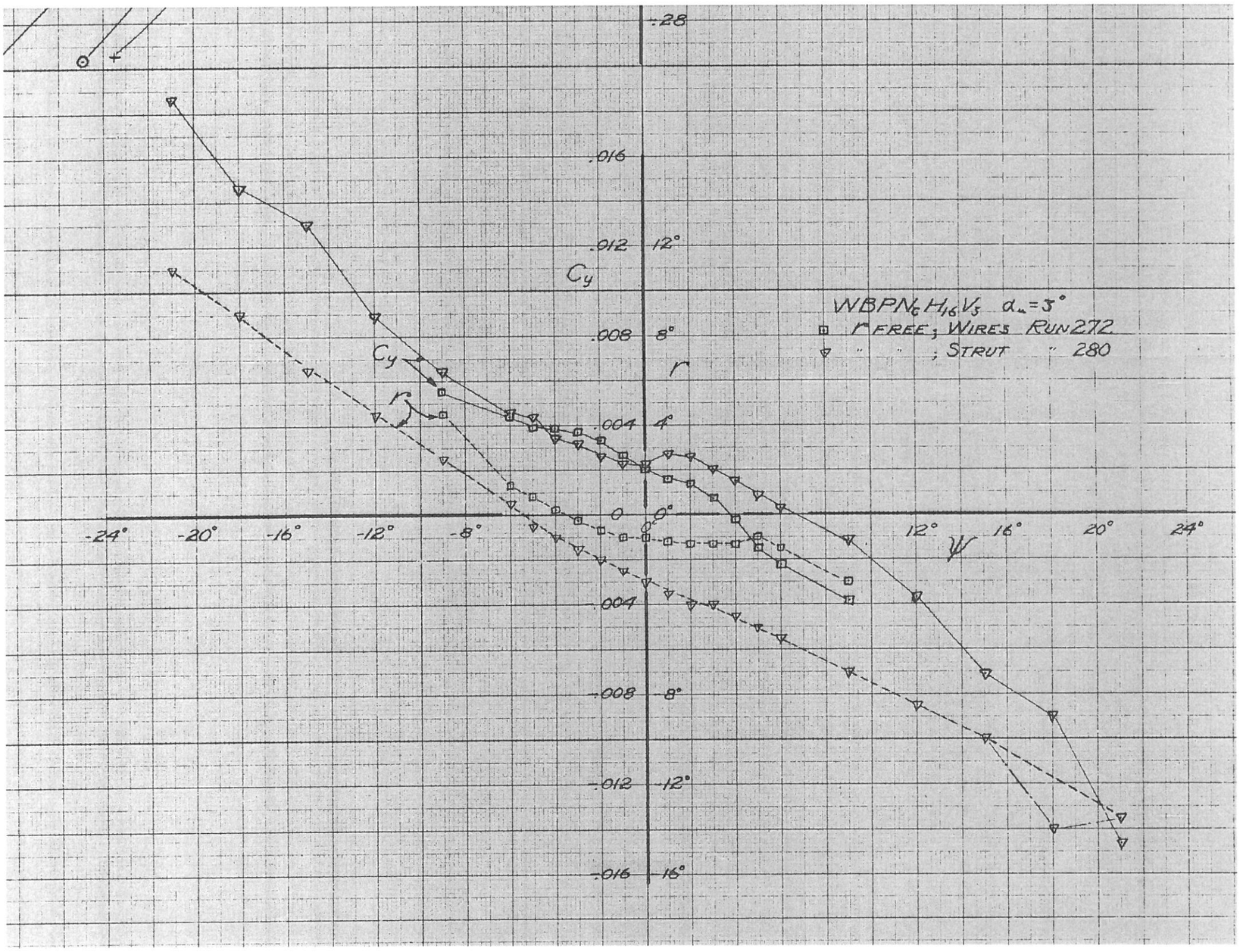

WBPN$_c$H$_{16}$V$_{10}$ α_w=3°
ψ=25° i$_t$=0° RUN 317
" 0° " " 318
" -25° " " 319
" -5° " " 320
" -7.5° " " 321
" -10° " " 322
" -15° " " 323
NOTE: SEE FIG. 16
S·t = 1675 ft³
C$_{Hr}$
Cy
r
GALCIT Rep 221
PAGE 149 FIG. 104
RUDDER HINGE MOMENTS AND EFFECTIVENESS AND RUDDER-FREE STABILITY WITH H$_{16}$V$_{10}$
-28° -24° -20° -16° -12° -8° -4° 4° 8° 12° 16° 20°
.032 .028 .024 .020 .016 .012 .008 .04 .08 .12 .16 .20 .24 .28 .32
Cy
r
Cy

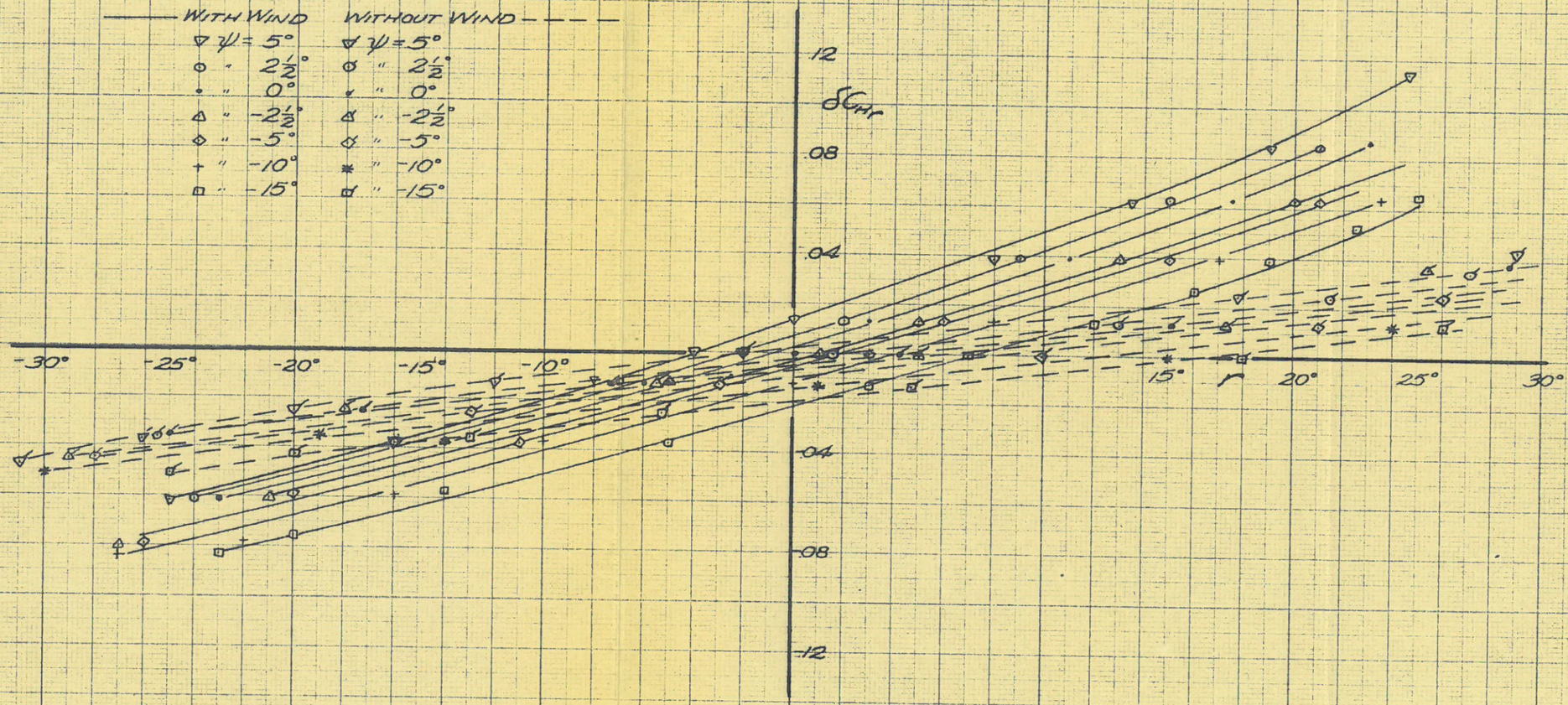

.020
.016
.012
.008
.004
-.004
-.008
-.012
-.016
20
12°
8°
4°
0°
-4°
-8°
-12°
-16°
-24°
-20°
-16°
-12°
-8°
0°
8°
12°
16°
20°
C_y
C_y
r
r
ψ
WBPNcH/16V/16 r FREE
r_t=0° RUN 316

GALCIT REP. 221

PAGE 149
FIG. 105




WBPN6 H16 V3 α = 3°
□ Γ FREE; WIRES RUN 272
▽ " " ; STRUT " 280
Cy
Γ
ψ
.028
.016
.012 12°
.008 8°
.004 4°
0 0°
-.004
-.008 -8°
-.012 -12°
-.016 -16°
-24° -20° -16° -12° -8° 12° 16° 20° 24°

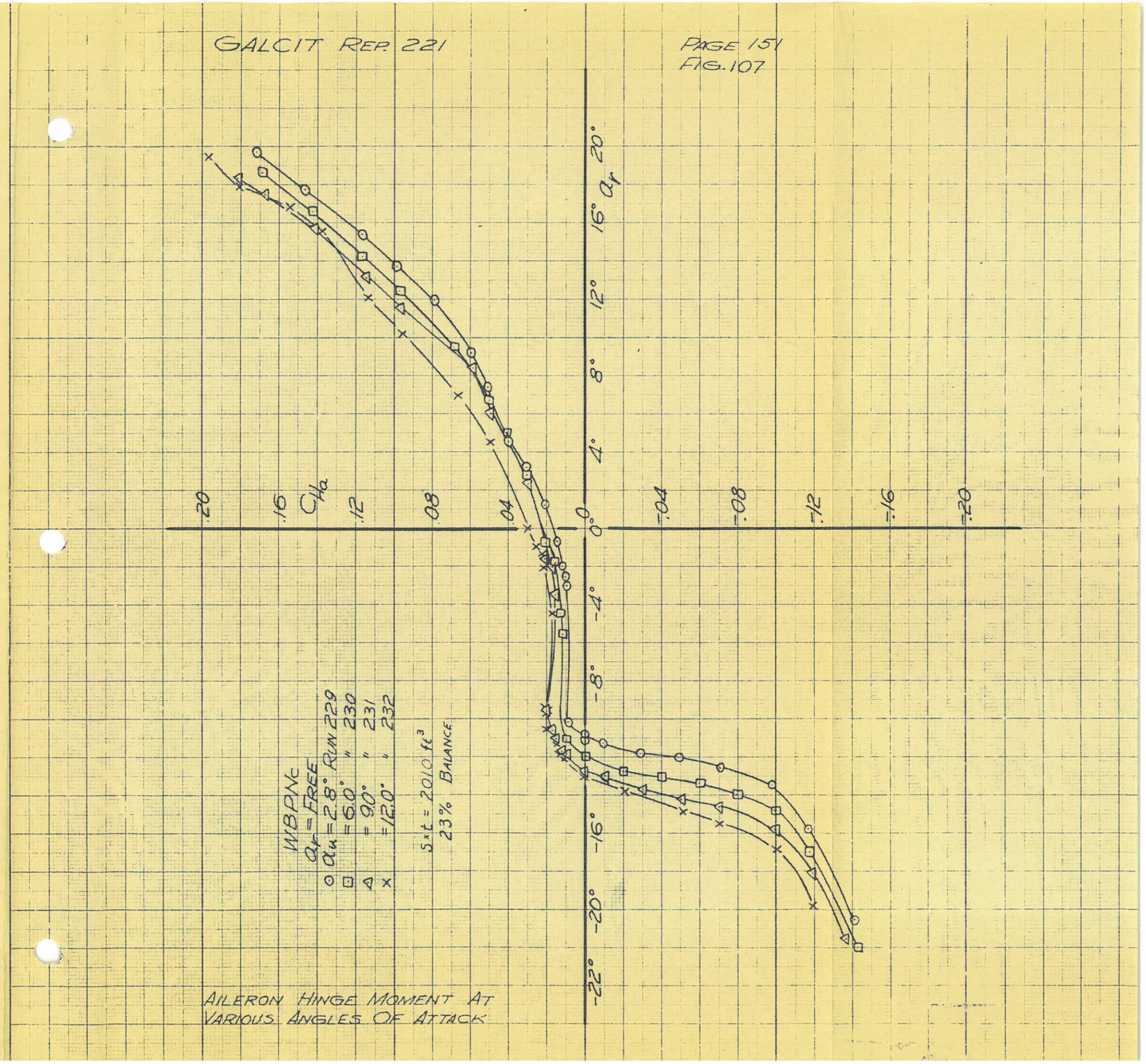


HINGE MOMENT OF STRUT AND STINGS IN RUDDER HINGE MOMENT SETUP (BASED ON $S_{ht} = 2896\ ft^2$ AND V_0 FOR 2V)

NOTE: δC_{HF} APPLICABLE PARTICULARLY TO RUNS 374 TO 384

GALCIT REP. 221

PAGE 151
FIG. 107



AILERON HINGE MOMENT AT VARIOUS ANGLES OF ATTACK

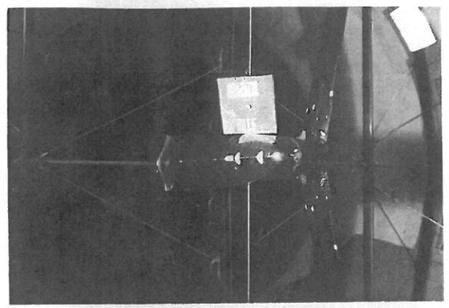


PHOTO 1.

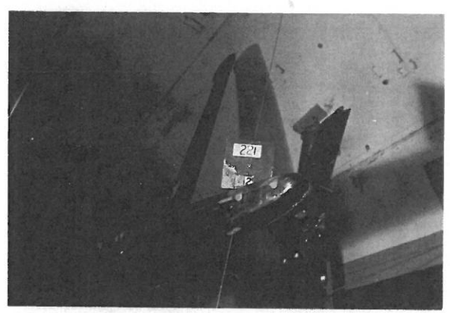


PHOTO 2.

WBN_cPH_3v, Run 6

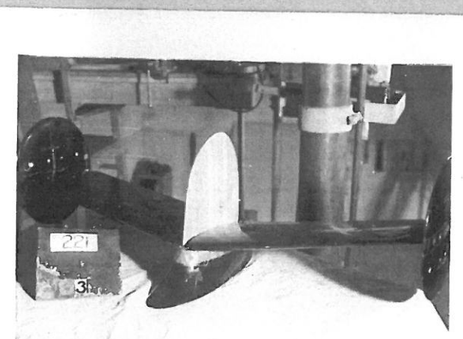


PHOTO 3.
H_3V_6

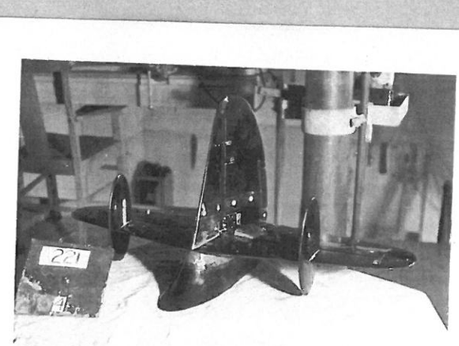


PHOTO 4.
H_2V_2, showing (left) bracket, b, on auxiliary fin

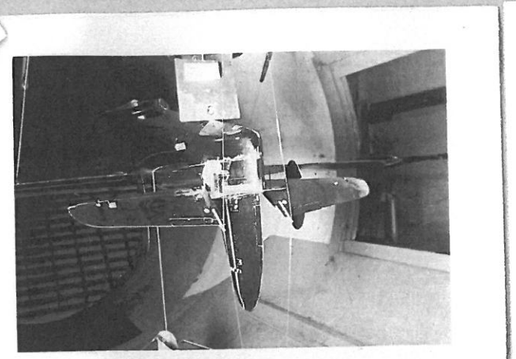


PHOTO 5.

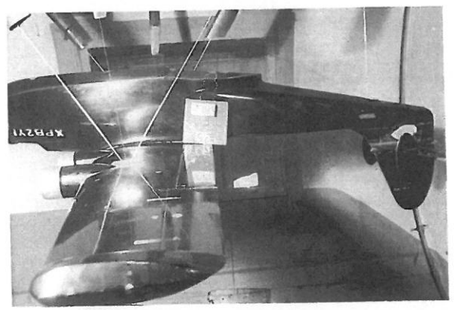


PHOTO 6.

$WBPN_cH_2V_2v$, showing elevator hinge-moment rigging

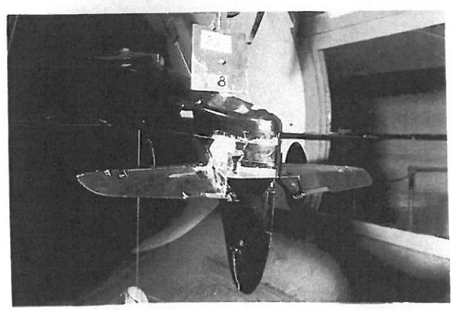


PHOTO 7.
$WBPN_cH_1V_2v$, showing setup for Run 96, elevators free, $e_t = -0.3e$

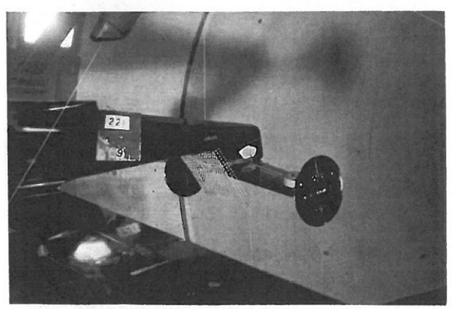


PHOTO 8.
$WBPN_cH_{16}V_3G$, Run 261

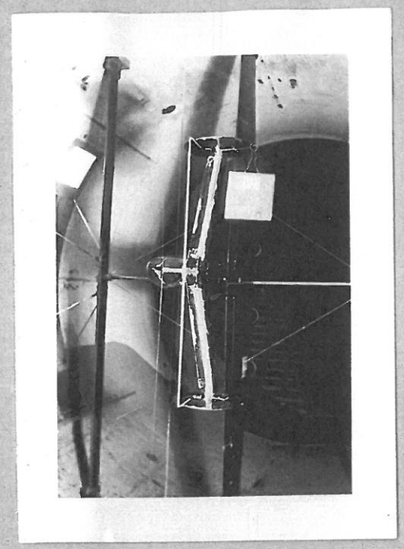


PHOTO 9.
$WBPN_6H_{16}V_3$, Run 280, showing setup for rudder hinge-moment tests with both rudders

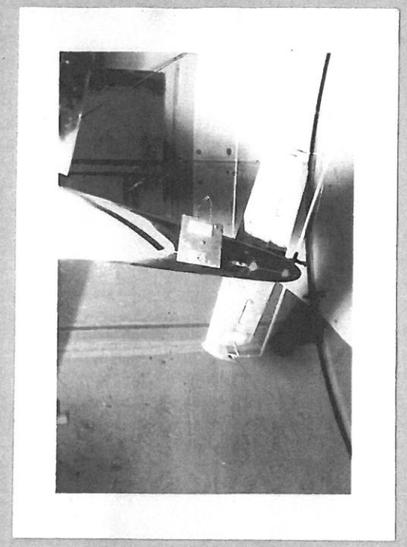


PHOTO 10.
Setup for Run 385, to determine tare hinge moment of rigging system used for twin rudders

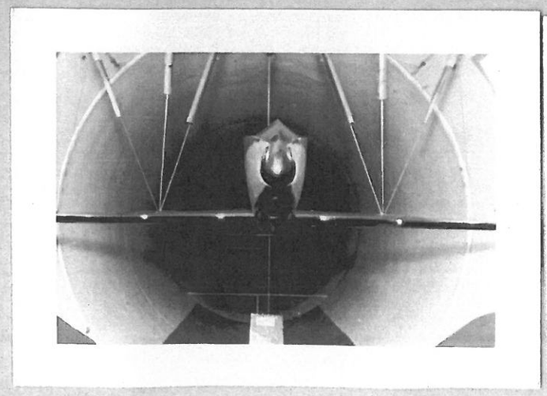


PHOTO 11.

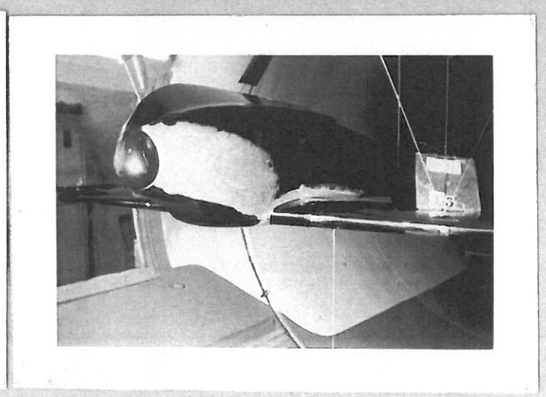


PHOTO 12.

WB_2P + fairing, Run 360

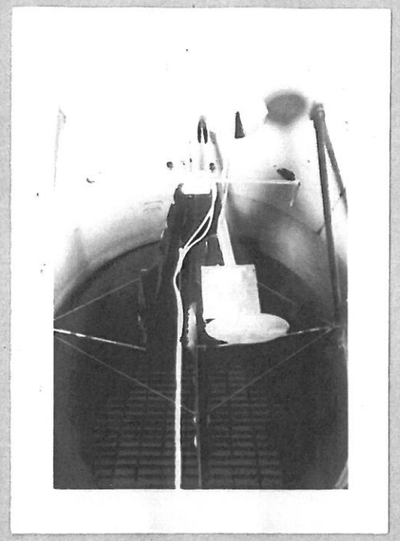


PHOTO 13.
Setup for Run 369: pitot tube in
position to measure wake of rigging wire

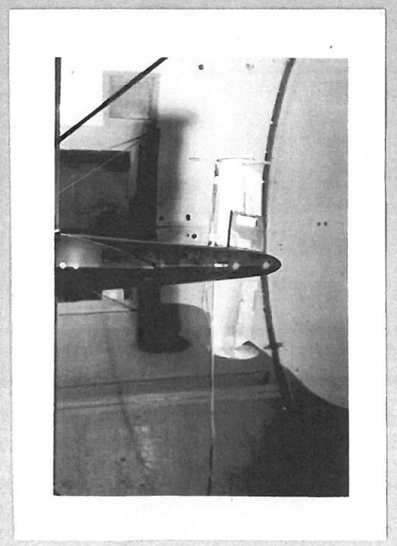


PHOTO 14.
Setup for Run 370: pitot tube in
position to measure wake of rigging wire